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Review Study of Identify Main Factor That Causes the Cracking and Potholes on Asphalt Pavement in Malaysia

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Abstract: In recent years, highway engineering has seen significant growth, necessitating good condition of pavement during the pavement facing the load of traffic heavy loaded vehicle and climate change we will see the change of behavior and condition of pavement Cracks are the common distresses that develop in pavement sector in Malaysia. According to the claim, pavement deterioration will create a dangerous environment for road users, resulting in traffic collisions. If there is a massive pothole on the road, for example, a motorist may strike the potholes. I indicated that excessive rut depth pavement degradation will result in a higher rate of collisions. Pavement care is therefore critical for ensuring safety as well as maintaining and extending the pavement life cycle. Cracking, potholes, bleeding, depression, and other types of road deterioration are examples. second, determine and classify the cause of the road damage and why it occurred on the road's surface. Many types of study have been conducted on this issue, particularly in Malaysia, such as finding solutions to address roadway damage, study into road damage specifications, and how to prevent road deformation, to name a few. As a result, the problem may be investigated in this study, as well as the primary elements and certain procedures that can be performed to categorize road damage in a systematic and unambiguous manner. in addition to bringing the broader public's attention to the issue.

Keywords: Road, Pavement, Malaysia, Pothole, Road Damage, Highway

1. Introduction

The transportation systems develop through time to address the problems of fulfilling people's ambitions. It has a huge impact on people's movement and accessibility, as well as the economy of every country. The fast expansion of transportation networks is concerning since it has substantial implications for highway users' safety as well as the environment's quality. Because of the weight and impact from many types of vehicles as well as design life for pavement are not infinite [1].

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This is backed by the fact that it is vital to have pavement strengthening done at or before the crucial level in to keep it in its original state and so workability of pavement is higher. More type of vehicle and heavy vehicle will be produced on the road as the economy and transportation system continue to expand. This will destroy the road physically and internally, and it may also risk the safety of road users [22]. Indicated that excessive rut depth pavement degradation will result in a higher rate of collisions. In addition, according to the Highway Safety Manual issued by the American Association of State Highway and Transportation (AASHTO) (2008), around 34% of road collisions are caused by a variety of pavement mix quality and other variables. Pavement care is therefore critical for ensuring safety as well as maintaining and extending the pavement life cycle. As a result, it is well study more serious about maintenance for pavement on a regular basis to maintain its serviceability [11].

In recent years, highway engineering has seen significant growth, necessitating pavement in the good performance and effective interdiction techniques. As a result, focus investigation to pavement condition when facing the climate change, heavy load, and traffic vehicle to reach the smooth journey to user. To do so, a variety of assessment procedures may be employed to assess pavement distresses, some of which are carried out by a human inspector by doing some observation, and others which are carried out using automated approaches. Cracks are the common distress in pavement constructions. Because cracks are such an essential aspect in pavement design in way crucial purpose investigate all sorts of cracks distress happy at asphalt pavement in Malaysia [22].

As previously stated, one of the hazard elements impacting pavement destruction was the increase in vehicular traffic, particularly larger cars, as well as 2 traffic loads. Cracking, deformation deterioration, fail aggregate, and edge fault are all examples of pavement damage. According to the claim, pavement deterioration will create a dangerous environment for road users, resulting in traffic collisions. If there is a massive pothole on the road, for example, a motorist may strike the potholes. This might cause the car's tire to burst, leading to accident [33]

The scope of this study is to review the studies which have carried out on road in Malaysia, as well as studying a few roads in other country like China, mainly main factors causing the occurrence of cracking and potholes in asphalt pavement especially in Malaysia. Second, the objective of this finding is to analyze big reasons occurrence crack and potholes either from internal or external factor that influencing performance of asphalt pavement in type of most road U2, U3 and U4 in Malaysia. High of traffic, environmental factor, air void and deterioration of drainage system are several factors was researcher have been stated on previous study. This research aims to review as many previous studies as possible to identify the main causes of road deterioration resulting crack and potholes on the road. Besides that, due to the roadways that people use in daily life and maintenance cost that repeatedly burden, easily to solve this problem if knowing the main factor. Next, information gathering by refer to an expert person in this field and related to topic the person is many experiences and good about knowledge related in this problem.

This research has recently been conducted on the damage to highways in a variety of locations and countries. Many types of study have been conducted on this issue, particularly in Malaysia, such as finding solutions to address roadway damage, study into road damage specifications, and how to prevent road deformation, to name a 4 few. All this research was done for the purpose of determining the best techniques to reduce the defect of road damage and how to cover it up with the best solution. As a result of the research conducted, the effect of road damage can be reduced, preventing accidents caused by road deformation [11]

2. Literature Review

Malaysia's road network has gone through numerous stages. The first stage occurred before the 1950s, when streets built for trade purposes, the second stage occurred during the 1960s and 1970s, when rural roads were built to speed up road development; and the third stage occurred during the 1980s and 1990s, when transportation problems were alleviated through the building projects of inter-urban roads [4].

Pavement engineers are tasked with analyzing pavements distress and deterioration on how this problem would be occur. Example like, to various traffic loads while also being subjected to various environmental conditions and material qualities. Previous studies are useful for assessing finding about the performance of roads and determining the major reasons of failure. If the pavement has been subjected to a succession of unrecorded repair, the work gets more complex [22]

Table 1: Summary of cracking and potholes factors that synthesis from literature reviews

Item	Cracking & Potholes Factors	Researcher (s)
1	Safety of pavement	[15, 16, 17]
2	Cracking aspect	[8, 15, 22,23,29]
3	Pothole's deterioration	[17, 19, 20, 21, 22, 31]
4	Pavement deterioration	[15, 16, 17, 20]
5	Type of road and pavement required	[1, 2, 3, 15, 20, 21, 24]
6	Pavement surface condition	[4, 5, 7, 25, 26, 27, 31]
7	Design life span for pavement according to type of pavement	[12, 17, 23, 29]
8	Fundamental of road designation and requirements	[4, 6, 8, 9, 10, 11, 13, 14, 30]
9	JKR standard	[12, 13, 15, 17]
10	Method of Repairing work	[2, 3, 4, 5, 6, 11, 12, 32]
11	Factors of influencing pavement damage	[15, 16, 19, 25]
12	External and internal causes	[9, 17, 18, 19 20, 21]
13	Importance of materials and procedure of work	[15, 24, 25, 26, 27, 28, 33]

Details of the element of cracking and potholes factors that can enhance pavement structure and causes the deterioration are discussed as follows.

2.1 Flexible pavement

Asphalt is the most prevalent bituminous substance, although it is readily damaged due to its thickness. This is because most asphalt surfaces are constructed on gravel lands. Depending on the temperature at which it is poured, asphalt is categorized as hot mixed asphalt (HMA), warm mixed asphalt, or cold mixed asphalt. as stated, the term "flexible pavement" refers to how the pavement surface expresses the degree of bending generated by driving in all succeeding layers. Bitumen surfaces, as well as foundation and subbase pathways, make up flexible pavements. rise Furthermore, the load distribution property of layered structures is used to produce flexible pavements [22].

2.2 How Pavement Work.

Pavement has served as a barrier to keep the ground from being affected by vehicles since the long time ago start wheel technology was found in this world. Before there was pavement, there was compacted dirt, which served its purpose if the foundation surface was level, and the traffic was simple and steady. As shown by the Roman civilization's greatest accomplishment, which was the development of highways. Their technique at the time was to create a layered and tiered road surface structure. At the time, improvements in this field allowed the vehicle to be stabilized, and the consistent distribution of wheel pressure on the road avoided perforated and uneven surfaces. One of

the technologies enjoyed to this day by practicing a layered road surface was invented with this idea [12].

2.3 Causes of pavement failure

The most frequent road defects discovered in the field include potholes, cracks, edge flaws, depressions, and corrugation. At the same time, pointed out that traffic 9 congestion, pavement age, road geometry, weather, drainage, construction quality, construction materials, and maintenance policies are all major contributors to road degradation. Understanding the causes of pavement failures, on the other hand, is a crucial first step in reducing risks and improving road performance [5].

2.4 Loading and traffic volume

When it comes to per capita income from the domestic product, and overall level of living, among other aspects, developing nations are nations with economies that have substantial growth and security (Justin, 2018). Developing countries will see a rise in a variety of industries, including factories, shops, infrastructure, and housing areas, with the majority of these involving increased construction and increased road use for goods transportation. Malaysia, on the other hand, is the world's largest producer of palm oil, with agriculture accounting for 39% of the country's GDP Occupational health and safety policies and programs [6].

Due to the existing condition in the region, such as building construction, oil palm tree gathering, and other activities, the road pavement may receive a heavy load from cars at times. According to the 10 table above, the most important elements determining the amount of road damage in the country are heavy vehicles, delamination, cracking, and potholes, followed by wet weather/high rainfall intensity

2.5 Design and manufacturing flaws

The selection of the asphalt design (which prevents water from entering) or the selection and design of the wear route (which prevents water from penetrating) will provide no difficulty (which prevents water from penetrating). This is due to poor design and fabrication, which causes the pavement to deteriorate in strength and stability as the original path is broken and eroded. To ensure a good pavement, the pavement foundation must be built properly and in accordance with standard procedures, as well as the design and construction of the pavement itself. It's easy to trace the origins of poor design and production. This is due to excessive cost-cutting during the original design and construction process, or because property owners insist on low-cost alternatives [3].

If the design calls for six inches of base course but the contractor only installs three, the weight of the traffic will not be evenly distributed, causing the pavement to crack. While this problem might be expensive to correct, it is not as significant as soil structural issues. The placement of extra layers of asphalt is frequently used to remedy a lack of structural stability. In this situation, it's vital to consult with a civil engineer to ensure that proper drainage patterns are maintained despite the additional thickness.

2.6 Environmental impact

High rainfall puts individuals at risk of flooding and, in the worst-case scenario, causes road pavement to crumble, causing economic loss. However, such road pavement failures must be investigated further to determine if the failure is due only to a natural calamity such as flooding or to other causes such as overloading and poor construction quality. This research is critical since there is now no instrument for analyzing pavement failure as a decision-making system that can separate road pavement failure causation variables into the category of natural catastrophe [8]. The importance of moisture in pavement construction is highlighted in this guideline. Rainfall data collected during the life of the road will be analyzed to see if there were any significant deviations from the area's typical precipitation quantity, as well as information on rainfall distribution. Although the rainfall may have been on par with the long-term yearly average, records show that it was concentrated over a short

period of time, resulting in unusual moisture conditions under the pavement [8]. Vehicles travelling over the road surface provide a lot of pressure to the water, pressing it deeper into the road fabric and causing it to break apart. [3]

2.7 Poor Drainage

The highway drainage system includes the pavement surface, shoulders, drains, and culverts, as well as the water management system, which includes the pavement surface, shoulders, drains, and culverts. These drainage system components must be designed, built, and maintained effectively. Poor drainage is typically a significant factor when a road breaks down. Due to inadequate construction, water might be channeled back onto the road or prevented from draining away. When there is too much water on the surface mixed with driving, potholes, cracks, and pavement disintegration may result. The effect of poor drainage on road pavement was studied [3]. The researchers discovered that when the moisture level in the pavement rises, the pavement's strength diminishes. As a result, insufficient drainage leads the pavement to break prematurely. Poor drainage caused moisture damage to asphalt surfaces, which was researched. They discovered that the loss of strength and durability due to water impacts is caused by the asphalt film's loss of cohesion 12 (strength), failure of the aggregate-asphalt adhesion (bond), and deterioration of the aggregate particles exposed to freezing [14]

2.8 Construction with Low Quality Materials

On The use of low-quality building materials has a negative impact on the road's performance. This may include things like incorrect aggregate grading for the base or subbase, as well as weak subgrade soil with insufficient bearing strength. When poor or average foundation materials are employed in the building of a pavement, its performance will suffer. These compounds, he found, may hasten pavement deterioration, causing rutting, cracking, shoving, raveling, aggregate abrasion, poor skid resistance, weak strength, reduced service life, or a combination of these issues [9]. When wetted, base materials with a high fine's concentration are prone to losing strength and load-bearing capacity. Marginal base materials, on the other hand, frequently cause discomfort and can lead to premature failure in the form of severe shrinkage cracking, rapid fatigue cracking, and a general loss of stability [5].

2.9 The possible causes the crack.

The necessity of pavement structures distress has been recognized by academics for years. The causes vary depending on the nature of the pain. Weak subsurface connection between both the road pavement, on either hand, was a major factor in the breakdowns. According to prior research, the interlayer connection is necessary to assure that all layer's work as a single organism, reducing cracks and deformation in the pavement. For most pavement designs, the asphalt layers are thought to be completely bonded together, and no displacement occurs. According to various debates, applying a thick asphalt bonding coating (or tacking coating) at the interfaces of the pavement layers is the most effective method for assuring interlayer bonding as multiple incidences of pavement pain owing to poor connection among asphalt layer have been reported in different countries, full connection is not always accomplished [15].

The loss of load-bearing capacity and waterproofing typically causes the pavement to deteriorate more quickly. Cracks may be caused by a variety of factors, including Depression The surfacing's fatigue life has been surpassed the loss of load-bearing capacity and waterproofing typically causes the pavement to deteriorate more quickly. Cracks may be caused by a variety of factors, including Depression The surfacing's fatigue life has been surpassed, Age embrittlement of the surfacing, Reflection of cracks in underlying layers, Shrinkage and Poor construction joints [17]

3. Research Methodology

A flow of systematic method was designed to collect the main data and easily evaluate the data. Besides that, easily to make some comparison between the article to determine the variable and

possible factors of pavement damage and distress. indicated in Figure 1.

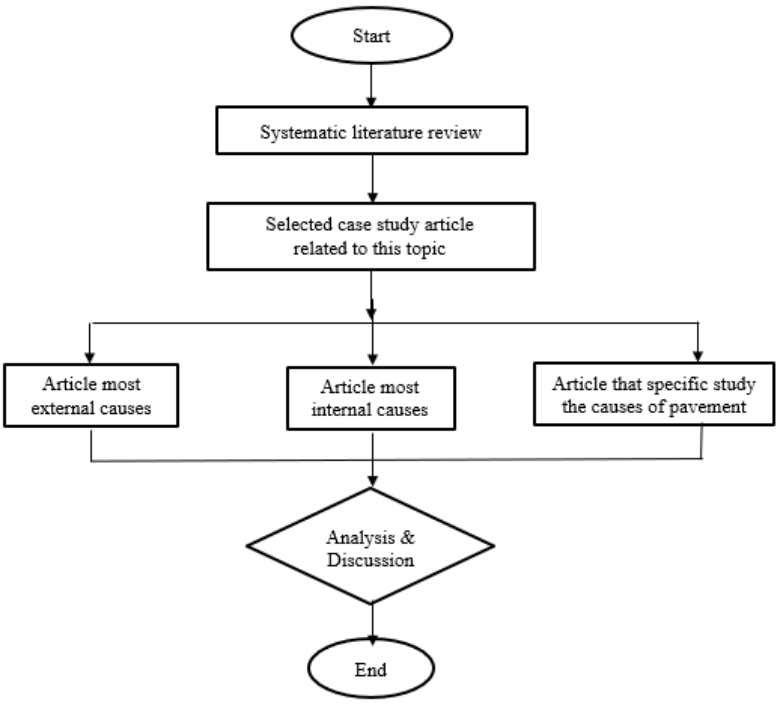

Figure 1: Systematic Method Flow Chart

A The systematic review provided a synthesis of the scientific literature in response to find a global solution for the road traffic problems and to relieve road congestion in key corridors. We use explicit methods of searching, selecting, and analyzing data. The purpose of this systematic review is to locate relevant existing studies based on a previously formulated research question, to evaluate and synthesize their respective contributions in this regard. In most cases, systematic reviews exceed integrated project delivery methods in literature reviews. The various aspect and factor take as the variables as possible factors will bring the deterioration for asphalt pavement. We can divide into external and internal factors include environmental influence. During this flow chart easily to make the choice and decision according to various article was related with this topic.

4. Result and Discussion

Table 1: Main Causes Cracking and Potholes Damage.

No	Author (Year)	Distress	Finding	Main Cause
1	Kordi, N.E / IR, Wahab, M.Y. (2012)	Cracking & Potholes	To prove it heavier axle load was bring a primarily damage of road. Performance of the road was deterioration occur more distress.	Traffic value of heavy vehicles

2	Nur Hamizah Zulkifili / Muslich Hartadi Sutanto (2018)	Cracking & Potholes	Lack of between the wearing course and binder course. will influence the performance	Moisture Water & air void Due to the high intensity of rainfall, there is a drainage issue.
3	Nasradeen A. Khalifa / Adnan Zulkiple (2020)	Cracking & Potholes	Classified road in Malaysia (JKR) depend on durability level, size and load to alert drives driving heavy vehicle	Traffic value of heavy vehicles
4	Lijun Sun, (2016)	Cracking & Potholes	The cracking distress is the mainly happen as deterioration of pavement. Neglect to repair the cracking distress continuously, would be occur more distress like potholes.	Traffic value of heavy vehicles
5	Highway Materials, (2018), UTM	Cracking & Potholes	Classified type of road either Rural or Urban in Asphalt Pavement in Malaysia. Learn the standard of JKR pavement performance	Poor interlayer bonding between pavement structure. Traffic value of heavy vehicles
6	F. N. HVEEM (2010)	Cracking & Potholes	Identifying type of cracking and portholes according to size, depth, and circumference at pavement.	Poor interlayer bonding between pavement structure. Moisture Water & air void
7	Tan Chin Chien, (2017)	Cracking & Potholes	Identifying repairing method are suitable use depends on distress example crack sealing is the cheap restoration alternative to preventive crack distress became bigger.	Due to the high intensity of rainfall, there is a drainage issue Moisture Water & air void
8	Pavement testing and interpretation of test data Andrew Nkaro (2000)	Cracking & Potholes	Because various kinds of cracking may be caused by different underlying reasons, it is critical to recognize the types of cracking, such as longitudinal, block, crocodile, and transverse cracking, during the visual	Due to ingress of moisture and weakening of pavement layers Due to the high intensity of rainfall,

			examination. Potholes are distinguishable from raveling by having a diameter of more than 150 mm and a depth of more than 25 mm.	there is a drainage issue
9	Pavement Design & Construction/ Advanced Highway Engineering Dr. Haryati Yaacob, (2013)	Cracking & Potholes	AASHTO Design Pavement Structure Method and Standard AASHTO variable aspect for design like; time, traffic, reliability, materials, environment, and serviceability. AASHTO road test	Traffic value of heavy vehicles The pavement reaction varies depending on the wheel load and design.
10	Evaluation Of Road Pavement Cracks In Malaysia Neral F. A. Bughrara, 2008	Cracking & Potholes	Gain knowledge about classification of distress and the possibility factor that contributed to distress occur in pavement road Malaysia	Traffic value of heavy vehicles
11	Factors influencing road infrastructure damage in Malaysia Intan R. Endut, 2014	Cracking & Potholes	Climate change is common will contribute to pavement damage will includes many work (repair, delay, social costs etc.)	Climate weather Traffic value of heavy vehicles
12	Factors Influencing Road Damage in Developing Countries Intan Najiha Akhmar Saharuddin, Dr. Doh Shu Ing, 2019	Cracking & Potholes	Pavement failures in Malaysia common occur when the drainage system is not work in good condition.	Traffic value of heavy vehicles Drainage is not work as good enough. intensity of rainfall
13	Investigating causal factors of road damage Jati Utomo Dwi Hatmoko, 2019	Cracking & Potholes	Researchers focus on the 3-damage factor excessive load factor, environmental factor (i.e. flood and sufficiency of drainage channel), and road construction quality.	Drainage channels that aren't working, uncontrolled overload caused by the closure of weighbridge stations along the route, and overall poor road maintenance work

14	A Guide to The Visual Assessment of Flexible Pavement Surface Conditions JKR, 2017	Cracking & Potholes	To do the correct way of maintenance this finding will teach knowledge about it, and the method standard of JKR Malaysia authorities Govern Malaysia about roadway.	Water proofing and loss of load distributing ability Traffic value of heavy vehicles Interlayer connection between the pavement structure is poor.
15	Investigation of Low Temperature Cracking in Asphalt Pavements, Adam Zofka, 2010	Cracking & Potholes	Do the experimental to identify cracking and potholes behavior, intensity, and properties in low temperature condition of asphalt pavement	Climates changes Moisture Water & air void
16	Evaluation of Cracking Patterns in pavement asphalt from Basics to Advances	Cracking	Type of cracking characteristics depend on size, depth, and circumference	Traffic value of heavy vehicles
17	Pavement Deterioration and its Causes. Sharad.S.Adlinge, Prof.A.K.Gupta, 2015	Cracking	Learn pavement behavior and condition.	Moisture Water & air void Traffic value of heavy vehicles
18	Initiation and Propagation of Top-Down Cracking in Asphalt Pavement. Lijun Sun 1, Gang Wang, 2018	Cracking	Heavy Vehicle will bring cracking damage to pavement continuously will bring more deterioration as potholes and settlement.	Traffic value of heavy vehicles
19	A Real-time Pothole Detection Based on Deep Learning Approach. : Yeoh Keng Yik, 2021	Potholes	Statistic pavement deterioration damage to user accident occur	Traffic value of heavy vehicles
20	Road safety: the potholes of neglect. H.A. Geziary, 2004	Potholes	The smooth roadways without damage and deterioration like potholes will ensure safety along journey to reach the destination.	Traffic value of heavy vehicles Lack of maintenance

4.1 Discussion

Based on these table as result can we discuss, mostly researchers were study deterioration of asphalt pavement about distress would be appear when the pavementis not in the good performance. Especially, cracking and potholes damage that they took about, these two distress or damage was common problem

when involving the roadways. Generally, the researchers do they study by knowing the main causes and source how the problem happen more than identified prevented way. Cracking and Potholes is the between one distress of pavement, and mostly study was conducted tofind both of this distress. Many past studies have divided main causes into external and internal factors. Based on research and observation the pavement damages by do the observation and analyze at districts, distress on the road is further categorized based on the size, depth, and surface circumference of the area that occurs. In addition, the position and vehicles passing through the road are considered as very important variables to study the actual cause of damage to the road. Among the main causes of road damage is, vehicle value and traffic loaded, because of water from rainfall which is prolonged in the long time the water will be full follow the drainage. the problem is when the drainage is not work well and moisture water & air void. On this situation, the road made must take overview various aspects, especially the aspects that lead to the main cause of damage to the road. The research about this topic should be many more to get the solution about this problem. Finally, we can find the proper way how to solve Cracking and Potholes damage in asphalt pavementin Malaysia.

5. Conclusion

For the conclusion that will be achieved what was stated in objective in project. As a conclusion it can be conclude that:

1. The onset of road damage is due to cracking distress that is not treated and maintained properly, which results in the emergence of other damages such as potholes and settlement, too many variations to determine with certainty the cause of road damage because it depends on the condition of the road, the area, and the materials used. In addition, the reason for this damage is because the cause of the damage is interconnected with each other.

2. Based on the finding, there are three major causes that previous researcher was highlight is Traffic value of heavy vehicle, drainage are not in good way, cannot flow rainfall round of and moisture water & air void. this damage is mostly influenced by external factors.

3. For the cracking damage is the common problem on the road especially longitudinal and crocodile cracking mainly happen when the road is faces traffic value of heavy vehicle. This is because, the design road of asphalt pavement was included many aspects especially durability to carry load at the same time. Even if the same quality standards are employed during design and construction, the lifespan of the pavement design decreases as load repetition and excessive vehicle loading all have an impact on the road surface.

4. For the potholes damage is the often problem that faced by road users. From the previous study this problem can be classified into small, medium, and bigger stages according to size of pothole, depth and circumferent of potholes damage. This problem occurs causes by moisture water & air void related with failed drainage system when water penetrates for a long time via existing fractures and cracks in the surface If alligator cracks, longitudinal cracks, and other asphalt stress fractures are 48 not properly repaired, water will erode the top all the way down to the sub foundation.

5. Based on the findings, it is shown that cracking and potholes are the main distress in Malaysia. Proper maintenance is required to overcome this problem to maintain the performance of pavement for smooth journey.

6. One of the reasons for road damage is due to road conditions that have reached the level of fatigue. This is due to the old roads. In this case the road is no longer functioning properly or is no longer flexible and not elastic. This situation is exacerbated by the road facing heavy vehicles carrying more loading than allowed. In this state of road fatigue, it is no longer able to withstand the overload imposed by heavy vehicles especially

7. In term of structure, the road is created to facilitate the travel of vehicles that use to travel from one place to another while bearing the burden of the vehicle. The road faces high tensile to withstand the

loading pressure from the vehicle. When the tensile is weak then the bonding structure of pavement will loosen causing road damage such as cracking and potholes.

5.1 Recommendation

Future study will require recommendations. Given the empirical research to examine pavement failures in relation to the many aspects this research must be continues with wide view and detail to get the many information and knowledge about pavement. Among the suggestions for improvement for this project is that this study needs to be done in more detail by finding more concrete and detailed reasons involving the structure of the road. such as avoiding failure to bond each material composition structure to the road pavement that can cause cracking and potholes by studying and designing a resistant mixture with high modified tensile. By using materials as a substitute for strong fine aggregate materials such as palm kennel, fly ash and so on. In addition, repetitive mechanisms such as air and water or known as agent factors are the biggest disadvantage to pavement by mixing materials that anti -agent can extend the life and keep the pavement in good condition. Beside that the record or evidence is very important to back trace the damage occur on pavement that ever exist and with this way easy to get the best solutions. Next, collaboration with the authorities to work together is the good decision for one purpose to get the solution this problem such as accident for used due to pavement damage, smooth the journey for roadways user and reduce repairing Thus, several aspects like costing use good materials, the effectiveness of work process, and the environmental geographical or soil conditions are advised. However, if the foundation is insufficient or weak, loads may have a crucial impact on the performance of pavements. As a result, more research in that area is advised. In addition, this study should be continued and done at the site that experienced the problem, that is to ensure that observations can be made more effectively

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