

Observation on One Lane Rigid Pavement at Jasin Plus Expressway For an Alternative Road With High Volume Traffic Area

Luqman Nul Hakim Hot¹, Mohamad Yusri Aman²,

¹Faculty of Civil Engineering and Built Environment,
University Tun Hussein Onn Malaysia, Parit Raja, Johor, 86400, MALAYSIA

²Faculty of Civil Engineering and Built Environment,
University Tun Hussein Onn Malaysia, Parit Raja, Johor, 86400, MALAYSIA

*Corresponding Author Designation

DOI: <https://doi.org/10.30880/rtcebe.2021.02.01.013>

Received 30 January 2021; Accepted 28 April 2021; Available online 30 June 2021

Abstract: Rigid pavement or concrete pavement are the kind of roads available in Malaysia. It is well known that the cost is slightly higher than the flexible pavement but it is safe, comfortable and effective for road users. These rigid pavement roads are often used on highways, high traffic volumes, accidents, heavy traffic lanes and intersections. This have increase the interest to the researcher to do this research. This study has been conducted to answer all previous questions while investigating the performance of rigid pavement. The tests involved in observing the road performance of the rigid pavement types are the sound test, the speed test, the volume of traffic, the skid resistance test using the British Pendulum tester, and its dimension. All tests were conducted at the North-South Highway of Jasin area because the area has a rigid pavement . An interview with Consultants and contractor engaged directly in the rigid pavement construction. Based on site tests, the data shown that the optimum performance of rigid pavement is pass for standard quality in heavy traffic area road especially in skid resistance limit, the speed vehicles on the road and the lifespan of road with the high volume of traffic per day. The interview of road specialist such as consultant and contractor to verified or support of theory that rigid pavement is suitable for heavy traffic area at the same time have an alternatives for low the cost maintenance and construction. In conclusion, awareness of concrete type roads as quality and ideal roads is well known but is still less widely used in Malaysia because of high cost, especially in areas with high volume of vehicles daily.

Keywords: Rigid Pavement, Flexible Pavement, British Pendulum Tester

Introduction

Road is one of the transportation system that connecting from one place to others. In Malaysia there is two type of road which is flexible pavement and rigid pavement. Flexible pavement is most widely used in Malaysia compared to the rigid pavement because of maintenance and construction cost.

*Corresponding author: mdyusri@uthm.edu.my

2021 UTHM Publisher. All right reserved.

publisher.uthm.edu.my/periodicals/index.php/rtcebe

Nowadays rigid pavement is suitable for selection of road in Malaysia because of increasing population and lead to higher number of road users. The structure of rigid pavement is very structural and able to accommodate the designed load and distribute to the load well without suffering damage or inability to withstand the load while providing a comfortable, safe, economical and achievable travel time.

Rigid pavement road are an alternative in solving road quality problems in Malaysia. Road quality problem can lead to increasing the number of road accident. To maintain the quality and increase the life span of road, the rigid pavement should follow the requirements and specification especially in terms of structure divided into concrete floor, base, sub base, sub grade, reinforcement, road shoulder and drainage.

Construction cost for rigid pavement is slightly high compared to flexible pavement but for a long term cost, rigid pavement is economical because lifespan of this road can last up to 30 years. Rigid pavement are known for their rough surfaces as they produce noise when friction between the tires and the road surface occurs. This situation is proof that rigid pavement good in get the resistance slip.

1. Literature Review

The World Health Organization (WHO) estimates that about 1.2 million people die and 50 million are injured every year because of an accident. Speed, negligence and poor quality of roads are the cause of accidents and contribute to 20% until 40% of the total number of road accidents [1]. The quality of major roads in Malaysia is the cause of the increase in the number of road accidents which in turn leads to high death rates. The research show that 18 fatal accidents have been recorded daily on major roads in Malaysia [2]. Rigid pavement are an alternatives in solving the problem road quality in Malaysia especially in high traffic flow area. The benefit of rigid pavement can reduce the number of fatal accidents because the road surface is safely and comfort the road users and the road surface is macro-technical which is good friction and thus avoid vehicles slipping during wet time.



Figure 1: Rigid pavement at Plus expressway

2.1 Design of Rigid Pavements

The main function of the roads is to provide comfort to users as well as able to accommodate the traffic load imposed. Road quality depends on the design, materials, and method of construction [3]. The lifespan for rigid pavement is 10 years to 60 years but depends on the quality material, geography and thickness of concrete floor. Rigid pavement have three type which is continuous reinforced concrete pavement (CRCP), Jointed plain concrete pavement (JPCP) and Jointed reinforced concrete pavement (JRCP) [4].

CRCP is a less complex design in rigid pavement. In terms of structure, CRCP not use shrinkage connection. The transverse cracks are allowed but held tightly together with steel reinforcement continuously. CRCP should be supported by good design factor to ensure long life span. The factors that need to be considered is modulus of concrete fracture, sub-grade, sub-site support and design duration traffic. This design is mostly used in Malaysia.

JPCP does not use steel reinforcement but uses contraction joint as intended to control cracking. Transverse connection located in structure and spaced to avoid cracking due to temperature and humidity. Dowel bars and tie bars in structure is also used to distribute the load from traffic

JRCP have a structure that uses steel reinforcement and shrinkage joints to assist in controlling cracks which further prove that rigid pavement have high durability. This structure for this type is very strong because have steel retainer to withstand cracks with a joint. The application of dowel bars with transverse connection is to distribute the traffic load.

2.2 Mechanism and Effectiveness of Rigid Pavement

The objective of pavement design method is to provide quality roads to users. The measurable pavement in terms of structural performance and performance of road functions. The structural performance is the ability to withstand the load of traffic moving on it. The performance of road functions is the road ability to generate comfort to users within a designed time frame. Rigid pavement have lie span from 10 years to 60 years but depending on the material quality and structure of concrete floor. Rigid pavement have lifespan up to 2.5 times than flexible pavement.

IRC (Indian Road Congress) is the most preferred method for designing rigid pavement because of IRC method is a step in determining the calculation of stress, strain, bending as a result of the applied load. This method is able to assist in the design of road surface thickness, connections and dowel rods and connection rod. The implementation of effective modulus in designing method can reduce the elasticity of modulus in concrete. The tensile strength design should be strong because if the concrete stress exceeds the tensile strength of the pavement then the surface cracking will occur.

Tests at pavement area and pavement structure should be carried out to ensure that the pavement are prepared from various obstacles that could damage the road. Among the test that should be performed are the physical characteristic of the sub-grade, physical properties of the concrete, thermal properties of concrete, effect of moisture on the strength and stiffness of the concrete [5]

2. Materials and Methods

Methodology is a specific detail and planning for research from the initial steps to the conclusion. The efficient research journey should have a structured, planned and clear methodology. The research must be on track as well as completed until getting the results and findings of study based on timeline given by University Tun Hussein Onn Malaysia. From the research conducted, the objectives of study should be achieved to determine the optimal performances of rigid pavements, to determine an alternatives on the cost of implementation of rigid pavement in areas with high volume of road users and the lifespan of the road in Malaysia, and to convey information about rigid pavement to the general public whether it is suitable for use in areas with a high volume traffic area through the thesis.

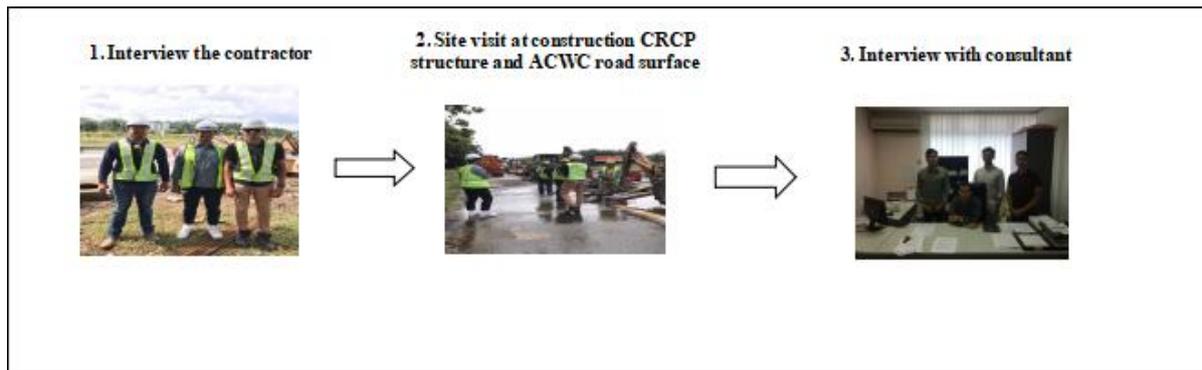


Figure 2: Interview with respondent contractor and consultant

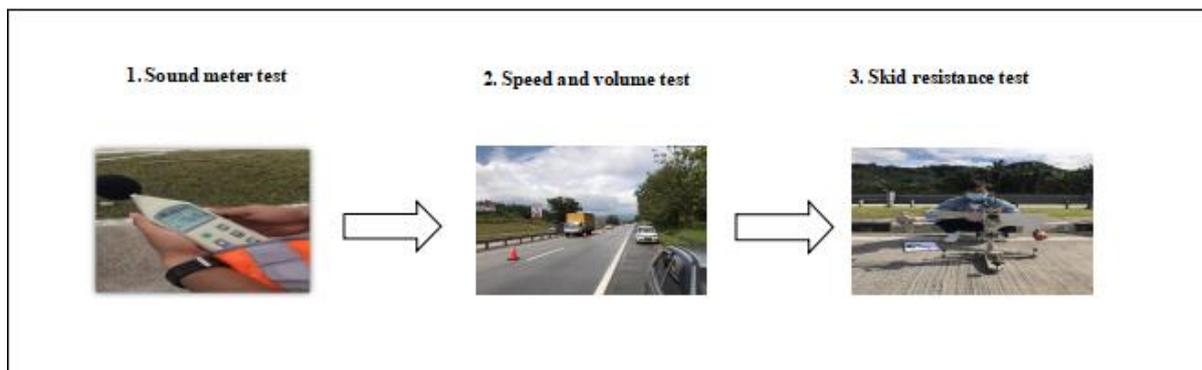


Figure 3: Collection field data at North-South expressway one lane at Tapah

3. Results and Discussion

a) Sound meter and speed test

Table 1 : Data sound meter test and speed test at rigid pavement

Car	Sound meter in vehicles (dB)	Sound meter outside vehicles (dB)	Speed (Km/h)
1	73.6	78.1	81.0
2	73.2	79.1	84.0
3	75.6	88.0	90.0
4	-	84.1	87.0
5	-	86.7	89.0
6	-	78.4	80.0
7	-	80.9	90.0
8	-	82.2	83.0
9	-	85.7	89.0
10	-	84.6	89.0
Average	74.1	82.8	86.2

Table 1 shows the speed and and noise limit data of vehicles when passing through rigid pavement road one lane on the North-South highway area Jasin. The speed of vehicles is taken using stopwatch while sound limit test use a sound meter device. The range for the noise limit in the vehicle when passes through one lane road is 74.1 dB Next the noise limit from outside the vehicle when the vehicle passes though the one lane road is 82.8 dB. Finally the speed range is 86.2km/h.

b) Volume traffic

Table 2 : Volume traffic at rigid pavement Jasin

Time	Motorbike	Car/Van	Lorry
12:00	10	49	18
12:10	4	43	9
12.20	13	53	10
12:30	6	45	20
12:40	15	51	5
12:50	13	49	15

Table 2 shows data volume traffic one lane road at North-South highway area Jasin during 12pm until 1pm. This time is suggested by person in charged because of safety factor. From the 60 minutes observation, the volume of traffic at North-South highway one lane road area Jasin is 8 vehicles/min.

c) Skid resistance data

Table 2 : Data of Skid resistance at rigid pavement Jasin

Element		Data	Average
Dry surface	Rough	120	104
	Medium	105	
	Smooth	87	
Wet Surface	Rough	90	79
	Medium	77	
	Smooth	69	

The data taken were filtered by dividing it into wet and dry surfaces to see the similarity situation during hot and rainy times on rigid pavement. The data taken also divided into three types of surface such as rough, medium and smooth.. The results of this experiment show that the surface of rigid pavement in various situations is still safe and pass the level of skid resistance which is 55. The total range for dry surface is 104 while for wet surface is 79.

d) Interview of consultant

Opus International (M) Berhad is a consulting company on behalf of Plus Expressway Bhd, a government concession company that maintains the North-South highway. The company expertise especially in terms of designing improvements and maintenance of roads, drainage and landscaping. The rigid pavement technology has been around for a long time in Malaysia since first phase of North-South expressway. They also stated that rigid pavement is very durable and strong for high traffic flow area and it can survive until 28 years based on Plus expressway experienced. Although the lifespan not exceed into 40 years but it is much better than flexible pavement that only sustain until 10 years.

The Opus International (M) Berhad work scope is provide good planing in choosing the type of road because to avoid frequent maintenance because it is dangerous for traffic, to provide high quality road and save maintenance cost. Opus also stated that the constraints of Plus Expressway Berhad is to cover cost of construction rigid pavement on the North-South Expressway due to the high cost and complex design from sub-site to road surface. This causes the consultant to suggest an alternative which is to use the internal road structure from concrete and surface from premix. The combination of two elements of rigid pavement and flexible pavement is capable in producing roads with high lifespan and low construction cost. This alternatives is so useful because almost the entire North-South highway which still in two lanes has a combination of flexible and rigid pavement.

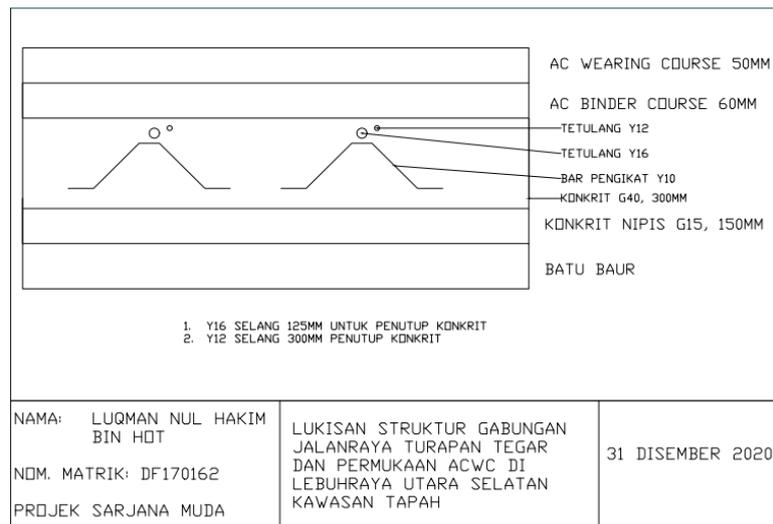


Figure 4: Guidelines for the combination of structure rigid pavement and ACWC as surface

e) Interview with contractor

Bumiikhlas Sdn Bhd is a contractor company on behalf of Plus Expressway Bhd, a government concession company that maintains the North-South highway. This company is one of the company that has expertise in construction and maintenance of rigid pavement in Malaysia. The interview was carried out at North-South expressway area Tapah. The pavement type in Tapah is combination from rigid pavement as structure and flexible pavement as surface. This type is innovation from Plus Expressway Berhad for cost saving especially for construction and maintenance cost.

Bumiikhlas Sdn Bhd also stated the purpose of North-South expressway in the first phase using type of rigid pavement because refer from Japan because Malaysia adopted “Look east Policy”. The type of rigid pavement that is often used in Malaysia is Continuous Reinforced Concrete Road (CRCP). CRCP is often used because of the material is easy to find and the cost is cheap compared to other types besides it is suitable with weather and geographical of Malaysia.

The construction of rigid pavement is complicated because it requires good weather and expertise to ensure quality maintained. The construction period is very important such as curing because to avoid structure not well functioned and to maintained the long lifespan and the level of roughness. Sealant joint is used at the road surface to prevent concussion during the expansion and contraction process that can caused cracking on the road surface. The construction of rigid pavement takes a long time to be opened to the users which is 3 days after finished compared to flexible pavement which can be opened to users after 2 hours project completion. From the innovation Plus Expressway Sdn Bhd to use method combination two elements which is rigid pavement as structure and ACWC as surface able to speed up the construction period

Bumiikhlas Sdn Bhd also in line with Plus Expressway opinion which to combines two element rigid pavement as structure and ACWC as surface due to the cost saving and ideal for road maintenance. The maintenance for rigid pavement is in limited scope unlike flexible pavement that can be maintained with a road patch that depends on defect area. For example the patching material in maintenance rigid pavement is high quality cement which is “Denka” that only can patch with an area of 2mx2m. If the area of patching is exceed 2mx2m, the patching strength will weaken and reduce the strength of road.

Discussion

From the field test, the data shows speed limit is exceeding 60km/h. Next the noise limit inside the vehicle is 74.1 dB and 82.8 dB for the outside vehicle. The data is under controlled because does

not exceed 120 db. Next, for the skid resistance data it shows that 104 when dry surface and 79.3 during wet surface. Both situation is under control because exceed 55. The interviews with professionals shows that the study about rigid pavement are much better than flexible pavement especially for areas with high traffic volume. The consultant and contractor also gave suggestion on the combination of two roads element which is rigid pavement as structure and flexible pavement as surface can be an alternative in addressing the issue of construction costs and maintenance costs

4. Conclusion

In conclusion, it shows that the rigid pavement is suitable to implement in high volume traffic road in Malaysia. The results from collection site data and interview the respondent shows the quality on performance rigid pavement especially in supporting and distribute load from vehicles. The obstacle in term of cost construction and maintenance can be avoid by implementing the combination of rigid pavement as structure and flexible pavement as surface. The optimal performance for North-South highway area Jasin have been tested and the results shows the road good in skid resistance, sound limit and the lifespan can sustain until 28 years

Acknowledgment

The authors would also like to thank the Faculty of Civil Engineering and Built Environment, Universiti Tun Hussein Onn Malaysia, for its support.

References

- [1] Seen, K. S., Tamrin, S. B. M., & Meng, G. Y. (2010). Driving fatigue and performance among occupational drivers in simulated prolonged driving. *Global Journal of Health Science*, 2(1), 167
- [2] M.H Othman, Z.Haron, M.R Hainin, K. Yahya, H.Yaacob, M.E. Sanik. (2015). Malaysian Transverse Rumble Strips: A Review and Recommendations for Practice. *Jurnal Teknologi (Sciences & Engineering)* 73:4 (2015) 117–123
- [3] Peter C. Taylor, Steven H. Kosmatka, Gerald F. Voigt, et al. (2007). *Integrated Materials and Construction Practices for Concrete Pavement: A State-of-the-Practice Manual*. No. HIF - 07 - 004
- [4] Mohd, N. S., & Hamsa, A. A. K. (2017). Evaluating the Effects of Transverse Bar on Vehicle Speed at an Arterial Road in Kuala Lumpur. *Asian Transport Studies*, 4(4), 723-740. .
- [5] Saurabh.J, Dr. Y. P. Joshi, S. S. Goliya. (2013). *Int. Journal of Engineering Research and Application* Vol. 3, Issue 5, Sep-Oct 2013pp.119-12