International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 4, Issue 10, October-2018

POLISHED STONE VALUE

Rushabh Maru[1], Mr. Pritesh Bhana[2]

[1]*Civil Engineering, Thakur College of Engineering and Technology,*
[2]*Civil Engineering, Assistant Professor of Thakur College of Engineering and Technology*

Abstract— PSV means polished stone value. The PSV test method is widely used throughout the world to measure the resistance of the anti-slip device. This is more important evidence that you can create an aggregate if you want to use it as a road surface. If an aggregate polish too much under the polishing effect of vehicle tires the road surface becomes very skidder, especially when wet and the number of skidding accidents can increase. This paper illustrate study is carried out on different type of aggregate in order to cater the need of varying climatic conditions prevailing in India and amount of traffic increasing in India and to determine the impact on skid resistance of aggregate. Thus different types of aggregates were randomly taken from the different quarry from the construction site, then the sample was prepared according to the IS code and IS specifications. The main objective of this, was to determine that for different type of aggregate there is different value of PSV and PSV depends not only on the aggregates exposed but also the quality of the aggregate, size of aggregate, strength. Thus, four types of aggregates were randomly taken from the different quarry from the construction site, then the samples were prepared according to the IS specifications. After preparing the samples all the four different types of aggregates with different size of aggregate were assessed using standard PSV test and three alternative variations using the same equipment. These variations include use of coarse emery only, fine emery only and extended duration of polishing. Further these variations were tested under dry and wet conditions. For highway engineers, it would be valuable to be able to predict the long-term skid resistance of bituminous surfaces before the pavement was constructed & that's why PSV should be known. Higher the test result, more polish resistance the aggregate is. In designing road engineer specifies the minimum value of PSV that the aggregate used in the surface has to have. The minimum value depends on volume and type of traffic using the road. For different aggregates, value of PSV is different. Also proves that PSV depends not only on the aggregates exposed but also the quality of the aggregate, volume of traffic, strength.

Keywords— PSV; Skid; Macrotexture; Macrotexture; Aggregates;

I. INTRODUCTION

According to MoRTH, India leads the world in road accident deaths with total number of crashes 0.497 million per annum (one every minute) and Number of people killed 1,42,485 per annum (one every 3.7 minutes) which means 16 people die every hour in India which equals to 390 deaths happening every day. The international studies show that between 15 to 18 percent of crashes occur on wet pavements (Smith, 1976; Davis et al., 2002; Federal Highway Administration (FHWA), 1990). According to the National Transportation Safety Board and the FHWA reports, about 13.5% of fatal accidents occur when sidewalks are wet. Many researchers have indicated that there is a link between rainfall and friction surfaces (Rizenbergs et al., 1972, Giles et al., 1962, McCullough et al., 1966, Wallman and Astron, 2001). Gandhi et al., 1991). In wet conditions, the layer of water covering the flooring acts as a lubricant and reduces the contact between the tires and the surface aggregates.

Therefore, wet pavement surfaces have less friction than dry pavement surfaces. Research studies have shown that an increase in average pavement friction from 0.4 to 0.55 would result in a 63 percent decrease in wet-pavement crashes (Hall et al., 2006; Miller and Johnson, 1973). The Kamel and Gartshore investigations also showed that, thanks to improved resistance to garbage, accidents with wet weather decreased by 71% at intersections and by 54% on roads (Kamel and Gartshore, 1982; al., 2006).

Pavement friction is primarily a function of the surface texture, which includes both micro texture and macrotexture. Pavement micro texture is defloured as "a deviation of a pavement surface from a true planar surface with characteristic dimensions along the surface of less than 0.5 mm," while the pavement macrotexture is defloured as "a deviation of 0.5 mm - 50 mm" (Henry, 1996; Wambold et al., 1995). On the one hand, the micro texture that is mainly an aggregate surface feature provides a rough surface that interrupts the continuity of the water film and produces resistance to friction between the tire and the pavement creating intermolecular links. On the other hand, the macrotexture that is a characteristic of the general asphalt mixture provides surface drainage paths so that the water dries faster of the contact area between the tire and the pavement, prevents the slip in water and improves the Resistance to wet friction particularly

in high-speed areas (Fulop et al., 2000, Hanson and Prowell, 2004; Kowalski, 2007). Many factors influence the level of slip resistance on an asphalted road, such as

- Micro texture and macrotexture,
- Age of the surface of the road,
- Seasonal variation,
- Traffic intensity,
- Aggregated properties,
- path geometry

II. NEED OF STUDY

MORTH have suggested a wide range of recommendation for the various properties of road aggregate used for the construction of surface corn of bituminous and concrete pavements. These properties include cleanliness, particle shape, strength, durability, water absorption, stripping and water sensitivity. The strength of aggregate is assessed by Los Angeles Abrasion Value or Aggregate Impact Value and the other properties also assessed by laboratory tests. As the aggregate used in surface corn of roadways are subjected to wearing due to movement of traffic, weathering due to seasonal variation. Therefore, the road aggregate should be hard enough to resist the abrasion and it is required to determine the abrasion resistance of aggregates in laboratory by Los Angeles Abrasion test machine. But, there are no clear recommendations of the skid resistance and friction value for the in-service pavement. As the performance of the pavements depends upon the aggregate exposed. Therefore, it becomes necessary to determine the skid resistance and friction value of in-service pavements under the action of traffic.

III. METHODOLOGY

In this research work the materials which we have procured were aggregates. The aggregate as mentioned in above are available in abundance and can be used for the road construction, as huge excavation is carried out at the material source site.

Testing of Aggregates:

For the research purpose the aggregate used was the simple basalt aggregate. The aggregate was firstly tested for the basic properties which are needed for a material to serve the purpose of aggregate. The aggregate for their use should satisfy the guidelines laid down in the IS Codes, IRC Codes and MORTH specifications. The aggregates will be tested for their hardness, toughness and crushing value. The test specifications are shown below in Table1:

Property	***Test Performed***	***Method of Test***	***Specification as per MoRTH 2013***
Toughness	Aggregate Impact Test	IS:2386 Part IV	Max 24%
Hardness and Abrasion	Los Angeles Abrasion Value	IS:2386 Part III	Max 18%
Crushing strength	Aggregate Crushing Value Test	IS:2386 Part III	-
Skid Resistance	Polished Stone Value (PSV)Test	IS:2386 Part IV	-

1) Determination of Los Angeles Abrasion Value

The aggregate used in surface corn of the highway pavements are subjected to wearing due to movement of traffic. When vehicles move to the road, the earth particles between the tire wheels and the surface of the road cause the abrasion of the aggregates of the road. The wheels of milled steel of vehicles driven by animals also cause considerable abrasion of the surface of the road. Therefore, the aggregates of the highway should be sufficiently resistant to resist the abrasion. The abrasion resistance of the addition is determined in a laboratory for the Los Angeles test machine. The principle of Los Angeles's abrasion test is to produce abrasive action by using standard steel balls that, when mixed with aggregates and rotated in a drum during a specific number of revolutions, also cause an impact on the aggregates It determines the percentage wear of the aggregates due to the rubbing with steel balls and is known as the abrasion value of Los Angeles.

2) Aggregate Crushing Value

The added value of crushing provides a relative measure of the strength of an aggregate crushing under gradual compression loading. With a total crushing value of 30% or higher, the result may be anomalous and, in this case, the value of 10% of the flours must be determined.

1) **Determination of Aggregate Impact Value**

The property of a material to resist impact is known as toughness. Due to the movement of vehicles on the road, the aggregates are subjected to impacts and are broken down into smaller pieces. Therefore, aggregates must have enough strength to withstand their disintegration due to the impact. This characteristic is measured by the impact value test. The aggregate impact value is the measure of impact resistance or sudden impact, which may differ from its resistance to gradually applied compression load.

2) **Polished Stone Value (PSV) Test**

PSV gives a relative measure of the extent to which different types of road stones on the wearing surface are polished under traffic.

The results of this test are used for comparative purposes only; limits cannot, at present, be specified for the polished-stone value in any particular set of circumstances. Where the wearing surface of a road consists largely of stone, the state of polish of the stone will be the dominant factor but other factors also affect the resistance of the surface to skidding.

Experimental design:

The in-situ skidding resistance of a road surface is dependent on the properties of the aggregate exposed, the flow of vehicles passing over it and road geometry insofar as this determines vehicle manoeuvres.

The tyre / surface interface is developed by Polished Stone Value (PSV) Test by which target values of skid resistance are met by the choice of an aggregate having appropriate resistance to polishing under the action of traffic. This is measured as part of a standard test known as the Accelerated Polishing Test followed by the measurement of Polished Stone Value (PSV), using a simple pendulum testing device. The BS accelerated polishing test, whilst simple in concept, is time-consuming. It consists of two 3-hours polishing stages using different polishing agents, with attention to the polishing machine between the stages and measurement of the PSV at the end which gives the friction value of the aggregate used.

A. Laboratory Prediction of Skid Resistance

To predict long term effect of repetitive action of traffic on friction or skid resistance of aggregate becomes necessary, which ultimately affects the performance of pavement in wet weather condition and the wet weather condition of pavement have significant effect on brake efficiency and accidents, to investigate the long term effect of traffic on aggregate test regimes were planed which are stated below:

Three different series of tests were carried out, test specimens for which were prepared according **IS : 2386 (Part IV) – 1963**

Series 1. Standard 6-Hour Test (Pendulum values recorded at 0 and 6 hours)

Series 2. Interrupted After 3-Hours Corn and Flour Emery (Pendulum value recorded at 0, 3 and 6 hours using the Corn and Flour medium)

Series 3. Extended Polishing Test Using Emery Flour (Pendulum values recorded at 0,3, 6, and 24 hours using only flour medium)

Figure : Samples prepared for Polishing

Series 1. Standard 6-Hour Test

From 5 different types of aggregate, 5 test specimens of each type were chosen. Initially test specimens were subjected to a Standard Test using the Accelerated Polishing Machine, and 6-hours of polishing (3-hours with corn emery followed by 3-hours of emery flour) was performed according to the test procedure defloured in IS : 2386 (Part IV) – 1963. The pendulum values obtained for the standard 6-hours test at 0-hour and6-hours. These Standard Test results provide the basis for comparison of any future alternative proposed testing procedures emerging through the findings of this research.

Series 2. Interrupted After 3-Hours Corn and Flour Emery

Samples for this test were prepared in accordance IS: 2386 (Part IV) – 1963. In this test the test specimens were subjected to Accelerated Polishing. The initial pendulum values were recorded, then test specimens were mounted on the road wheel and using corn emery as the polishing agent, they were subjected to 3-hours of polishing. All 5 test specimens were removed from the periphery of the road wheel, washed and cleaned thoroughly and the pendulum values were

obtained by the use of British Pendulum Tester (BPT) and the values thus obtained known as the British Pendulum Number (BPN). All 5test specimens were then re-mounted on the road wheel and were subjected to a further 3-hours of polishing using emery flour as the polishing agent. On completion of the test, final pendulum values were obtained. The main purpose of carrying out the interrupted 3-hours test was to try to establish whether it was corn emery or emery flour which has the most significant effect on the extent of polishing of test specimens, or in other words on pendulum values.

Series 3. Extended Polishing Test Using Emery Flour

After carrying out several tests and having established that the polishing occurs mostly during the first 3-hour of emery flour, one further and final test was carried out which lasted for 24 hours, and was interrupted every 3-hours, pendulum values of interrupted after 0,3, 6 hours through to 24 hours. Extended polishing was conducted in a series of tests to determine whether additional exposure would produce significant changes in rate or level of polishing.

IV. DATA ANALYSIS

Aggregate properties such as gradation, particle size, texture, shape, porosity, toughness, abrasion resistance, mineralogy, and petrography affect the pavement skid resistance. A complete set of measurements for evaluating different aggregate characteristics were performed, and the results are tabulated in Table 4.1

Table 4.1: Aggregate Test Results

	Obtained Results				
Test Performed	BH1	BH2	BH3	BH4	BH5
LA Abrasion Value Test %	14.77	18.52	13.11	13.33	15.1
Impact Value Test %	10.61	13.88	10.53	8.06	10.78
Crushing Value Test %	15.76	13.5	17.14	12.36	20.11
PSV at 0 Hour (dry)	68	66	70	78	76
PSV at 0 Hour (wet)	61	61	54	65	60

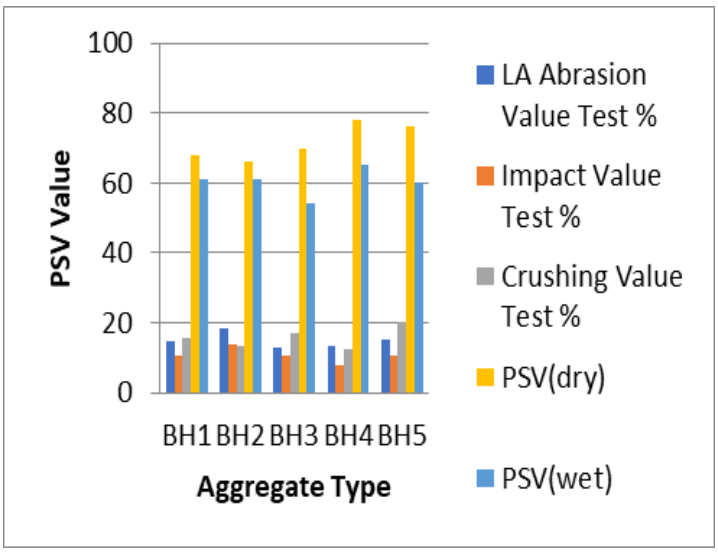

Figure 4.1Aggregate Properties

Series 1. Standard 6-Hour Test Results

The result obtained from standard 6 hour test show that there is decrease in PSV value from 78 to 63 for dry condition and 65 to 54 for wet condition for aggregate BH4. The test result also indicates that under the wet condition the PSV value is always found less than what is under dry condition. The summary of test result for all the type of aggregate is given in table 4.2

Table 4.2 Standard 6-Hour Test Results

S. No.	Aggregate Name	0 hour PSV Value		6 Hour PSV Value		Percentage Decrease in PSV	
		Dry Condition	Wet Condition	Dry Condition	Wet Condition	Dry Condition	Wet Condition
1	BH1	68	61	52	49	23.5	19.7
2	BH2	66	61	49	50	25.8	18
3	BH3	70	54	53	42	24.3	22.2
4	BH4	78	65	63	54	19.2	16.9
5	BH5	76	60	58	43	23.7	28.3

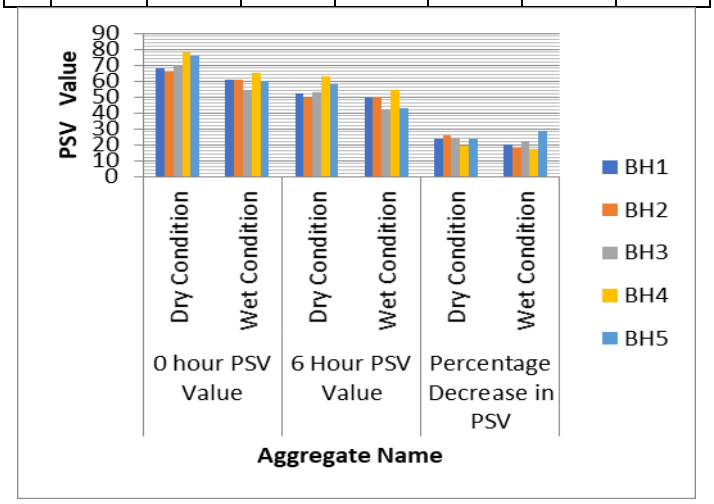

Figure 4.2: Standard 6-Hour Test Results

The above figure shows that the there is decrease of 19.2 to 25.8 percent under dry condition and 16.9 to 28.3 under wet condition in PSV value under standard Test procedure.

Series 2. Interrupted After 3-Hours Corn and Flour Emery

The result obtained from Interrupted After 3-Hours Corn and Flour Emery show that there is decrease in PSV value from 78 to 73 and 73 to 63 for dry condition during 0 to 3 hour of corn emery and 3 to 6 hours of flour emery respectively and 65 to 61 and 61 to 54 for wet condition during 0 to 3 hour of corn emery and 3 to 6 hours of flour emery respectively for aggregate BH4. The test result also indicates that under the wet condition the PSV value is always found less than what is under dry condition. The summary of test result for all the type of aggregate is given in table 4.3

Table 4.3: Interrupted PSV Values after 3-Hours Corn and Emery Flour

S. No.	Aggregate Name	0 hour PSV Value		3 Hour PSV Value		6 Hour PSV Value	
		Dry Condition	Wet Condition	Dry Condition	Wet Condition	Dry Condition	Wet Condition
1	BH1	68	61	63	59	52	49
2	BH2	66	61	59	57	49	50
3	BH3	70	54	62	50	53	42
4	BH4	78	65	73	61	63	54
5	BH5	76	60	70	55	58	43

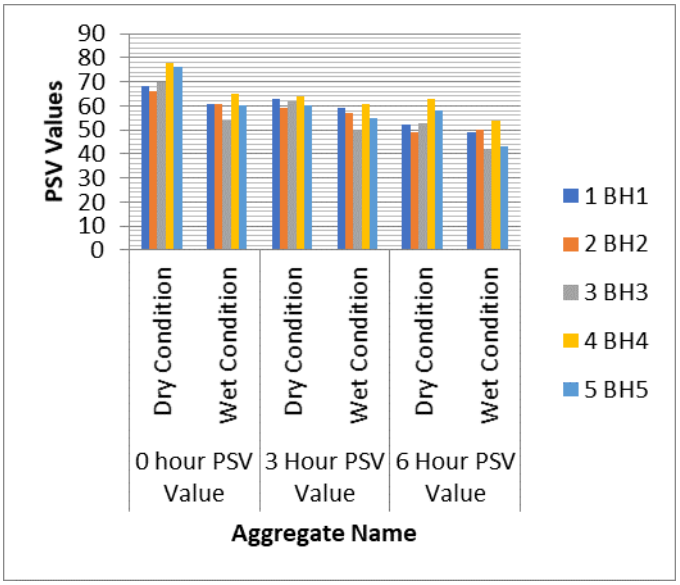

Figure 4.3: Interrupted PSV Values after 3-Hours Corn and Emery Flour

Examining the values measured after 3-hours, it becomes clear that the pendulum values at the end of corn emery stage shows a decrease compared with that measured before polishing began. By the end of the 3-hour stage polishing with emery flour however, the pendulum value has decreased substantially. This was the reason which prompted the author to suggest altogether eliminating the corn emery stage. Recognition of this phenomenon has led the author to carry out further tests in order to investigate the feasibility of completely eliminating the corn emery stage, in an alternative test procedure, thus adopting the use of emery flour as the sole polishing agent in all further testing procedures.

Series 3. Extended Polishing Test Using Emery Flour

Analyzing the results it is clearly demonstrated that most polishing occurs within the first 6 hours and from 6 - 24 hours polishing occurs but the amount of further polishing (reduction in pendulum value) is relatively small. Table 5.4 shows the pendulum values of interrupted at 0,3,6 and 24 -hourly intervals.

The results shows that the decrease in PSV value after standard 6 hour is only 3% to 5%.

Table 4.4: Extended PSV Values After 24-Hours using Emery Flour

S. No.	Aggregate Name	0 hour PSV Value		6 Hour PSV Value		24 Hour PSV Value	
		Dry Condition	Wet Condition	Dry Condition	Wet Condition	Dry Condition	Wet Condition
1	BH1	68	61	52	49	50	45
2	BH2	66	61	49	50	45	47
3	BH3	70	54	53	42	50	39
4	BH4	78	65	63	54	61	50
5	BH5	76	60	58	43	55	40

Figure 4.4: Extended PSV Values After 24-Hours using Emery Flour

The grand mean pendulum value obtained for standard test was 49.63 and for 30-hours was 50.41 this shows that an average increase of 1.5% in pendulum values. Table 5 shows a summary of correlation coefficients obtained from the extended polishing when solely emery flour is used as the polishing agent. The correlation coefficient when data of standard test are plotted against the flour polishing was found to be at the peak value of 0.90 at 3-hours, showing the best correlation on comparison with 1-hourand 2-hours.

V. CONCLUSIONS

- There is a complex interaction between the factors like aggregate type, strength and skid resistance during the engineering life.
- The study reveals that the aggregates which are suitable from strength view point, are susceptible to skid resistance.
- The results of the investigation indicated that it is possible to control and predict the friction properties of the pavement by selecting the type of aggregate.

- During the standard test series the decreases in skid resistance value is from 16.9% to 28.9 %, which indicates that during the early age of pavement there is decrease in its skid resistance.
- Interrupted test series reveals that during first half the decrease was 7% to 11% and during second half the decrease was 13% to 19%. This means the polishing of aggregates during second half is more and concluded that the polishing extent of emery flour is more as compare to corn emery. And we can suggest eliminate the corn emery stage.
- Extended Polishing Test Using Emery Flour reveals that during the later stage the decrease in skid resistance value is very less. Means most of polishing occurs during early life and ones the aggregates get polished skid resistance value might get constant..

REFERENCES

1. Abdul-Malak, M.A.U., Meyer, A.H., and Fowler, D.W. 1990. Research Program for Predicting the Frictional Characteristics of Seal-Coat Pavement Surface. Transportation Research Record 1217, Transportation Research Board, TRB, National Research Council, Washington, D.C.

2. Abe, H., Henry, J.J., Tamai, A., and Wambold, J. 2000. Measurement of Pavement Macrotexture Using the CTMeter. Transportation Research Record 1764, Transportation Research Board, TRB, National Research Council, Washington, D.C.

3. Agrawal S.K. and Henry, J.J. 1979. Technique for Evaluating Hydroplaning Potential of Pavements. Transportation Research Record 633, Transportation Research Board, TRB, National Research Council, Washington, D.C.

4. Ahammed A.M. and Tighe S.L. 2007. Evaluation of Concrete Pavement's Surface Friction Using LTPP Data: Preliminary Analysis and Texture Performance Models. Proceedings of the 86th Transportation Research Board Annual Meeting (CD), Washington, D.C., January.

5. Al-Rousan, T.M. 2004. Characterization of Aggregate Shape Properties Using a Computer Automated System. Ph.D. Dissertation, College Station, TX.

6. Alvarado, C., Mahmoud, E., Abdullah, I., Masad, E., Nazarian, S., Tandon, J., and Button, J. 2006. Feasibility of Quantifying the Role of Coarse Aggregate Strength on Resistance to Load in HMA. Center for Transportation Infrastructure Systems, University of Texas at El Paso, Research Report 0-5268-2, October.

7. Anderson, D.A., Meyer, W.E., and Rosenberger, J.L. 1986. Development of a Procedure for Correcting Skid-Resistance Measurements to a Standard End-of-Season Value. Transportation Research Record, No. 1084. Transportation Research Board, TRB,

8. National Research Council, Washington, D.C.

9. Balmer, G.G. and Colley, B.E. 1966. Laboratory Studies of the Skid Resistance of Concrete. American Society for Testing and Materials, Journal of Materials,Vol. 1-No. 3.