

# Performance of Ashpalt Concrete Wearing Course on the effect of duration of water immersion

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**Abstract.** Asphalt concrete as a wear layer, known as the Asphalt Concrete-Wearing Course (AC-WC) with a minimum nominal thickness of 4.0 cm. However, the use of AC-WC layers in the pavement structure is often faced with problems of performance degradation due to the development of various types of damage during the service life one of them is a result of the effect of water. In general, water has a negative effect on road pavement construction. Standing water can be caused by high rainfall, poor drainage systems, high groundwater levels, and water runoff. This research aims to look at the performance of the physical and mechanical properties of testing Marshall characteristics on a mixture of asphalt pen 60/70 wear layer (AC-WC) on the duration of water immersion from three different types of water. The specimen was carried out immersion testing from three types of water, namely clean water, brown flood water and black air with 30 minute immersion standards with variations of 1 day, 7 days, 14 days, 21 days and 30 days. The study outcomes shows several conclusions: (1) From the Marshall test results the physical properties obtained showed that the longer the immersion time the greater the VIM value obtained, the increase occurred in the type of brown flood water with the lowest Ph. Whereas the value of VFB in brown flood water immersion decreased the most as the duration of the immersion ; (2) The mechanical properties of the Marshall test results are stability values still meet the standards, while for the value of melt and MQ black flood water immersion is the most influential on the asphalt mixture.

## 1. Introduction

Asphalt Concrete is a layer on a pavement structure consisting of hard asphalt mixture and aggregate, mixed and spread in hot conditions and compressed at a certain temperature. Asphalt concrete as a wear layer, known as the Asphalt Concrete-Wearing Course (AC-WC) with a minimum nominal thickness of 4.0 cm. However, the use of AC-WC layers in the pavement structure is often faced with problems of performance degradation due to the development of various types of damage during the service life one of them is a result of the effect of water. In general, water has a negative effect on road pavement construction. Standing water can be caused by high rainfall, poor drainage systems, high groundwater levels, and water runoff. The method used in this research is laboratory-scale experimental methods. Tests carried out in this research encompasses testing the characteristics of materials and testing the characteristics of immersion three types of water [1-3].



## 2. Literature review

### 2.1. Asphalt concrete wearing course

Laston (Asphalt Concrete Coating), is a continuous graded asphalt concrete commonly used for roads with heavy traffic loads. Laston as a wear layer (Asphalt Concrete Wearing Course, AC - WC) is the topmost layer of laston that has direct contact with vehicles that pass above it. Laston wear layers have a finer texture compared to laston layers between the foundation and laston layers. Aside from being a supporter of traffic loads, this layer has the main function as a protective construction underneath from damage caused by water and weather, as a wear layer and provides a flat and non-slippery road surface. The provisions on the properties of mixtures for worn-out asphalt concrete mix in the 2010 Bina Marga specifications can be seen in Table 1 Definition of Mixture Asphalt AC-WC [4,5]:

**Table 1.** Definition of mixture asphalt AC – WC.

Parameter	Spec	AC-WC Coarse
Optimum Asphalt Content (%)	Min	4,3
Asphalt Absorbtion (%)	Maks	1,2
Number of Impact		75
VIM (%)	Min	3,0
VMA (%)	Maks	5,0
VFWA (%)	Min	15
	Min	65
Marshall Stability (Kg)	Min	800
	Maks	-
flow (mm)	Min	3
Marshall Quontient (Kg/mm)	Min	250
Marshall Stability Immersion after 24 jam 60°C (%)	Min	90

## 3. Asphalt testing

Asphalt testing includes of physical properties and engineering properties tests. Physical properties and Mechanical involves on *Marshall* test.

### 3.1. Physical properties test

- **Density Test**  
asphalt levels go up, density goes up to reach its peak then down. The peak density usually coincides with optimum asphalt content and peak stability. High density will produce the ability to withstand high loads and impermeability to high water and air.
- **Void in Mix (VIM)**  
The amount of pores left in the mixture after compaction. The bigger the portion, the less airtight and the more air in the asphalt mixture.
- **Void Mineral Agregate (VMA)**  
Volume of inter-granular cavity located between aggregate particles of a solidified pavement mixture [6].
- **Void Filled on Bitumen (VFB)**  
The percentage of cavities in solid aggregate filled with asphalt. VFB values that are too high can cause asphalt to rise to the surface when the pavement temperature is high, if it is too low it means the mixture is porous and easily oxidized.

### 3.2. Mechanical properties test

- **Marshall Stability**  
stability is the ability of road pavement to accept traffic loads without permanent changes in shape such as waves, grooves and bleeding. The stability needs are proportional to the function of the road and the traffic load to be served. The higher the traffic volume and the dominant heavy vehicles

traversed, then the higher stability is needed. Conversely, if the road is only for light traffic, very high stability is not needed.

- **Flow**  
flow values that are too high indicate that the mixture is inelastic and are more capable of following deformation due to load, while flow that is too low indicates that the mixture has a cavity that is not filled with asphalt higher than normal conditions, or the asphalt content is too low so that it has the potential to occur rift.

#### 4. Material

##### 4.1. Asphalt

Aspal type penetration 60/70 from PT. Pertamina.

##### 4.2. Agregate

Agregate from Subang Jawa Barat.

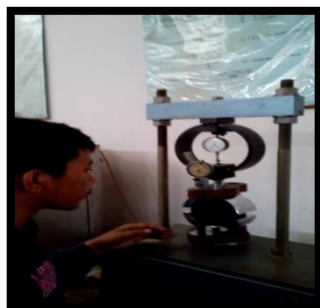
##### 4.3. Flood water

The water used comes from several places :

- Plain water is taken from the Bandung State Polytechnic laboratory.
- Brown Flood water is taken from flood water runoff near the Citepus river.
- Black Flood water taken from the Cimahi industrial area flood water runoff.

#### 5. Analysis methodology

The method used in this research is laboratory-scale experimental methods. Tests carried out in this research encompasses testing the characteristics of materials and testing the characteristics of three types of water. Furthermore, Marshall testing of asphalt mixture that was immersed in three types of water. The Asphalt Level of Oil used is a variation of 4%, 4.5%, 5%, 5.5% ,6% ,6.5 % ,7%. The OBC value is determined by using the Arrow Range method of the existing Marshall parameter, obtained by the OBC value of 6.15%. This research aims to look at the performance of the physical and mechanical properties of testing Marshall characteristics on a mixture of asphalt pen 60/70 wear layer (AC-WC) on the duration of water immersion from three different types of water. The specimen was carried out immersion testing from three types of water, namely clean water, brown flood water and black air with 30 minute immersion standards with variations of 1 day, 7 days, 14 days, 21 days and 30 days. The results of the study of the typical properties of the AC-WC layer questioned a decrease in density from the initial conditions to the 30 day of immersion [7].



**Figure 1.** Marshall testing.



**Figure 2.** Immersion.

#### 6. Discussion and data analysis

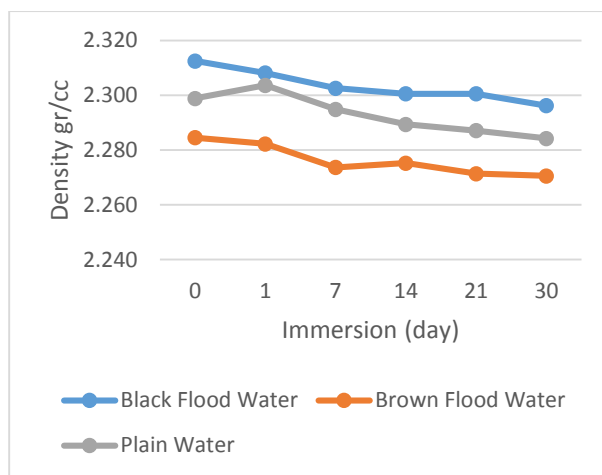
This part will describe the result of the study, water test and asphalt properties test (physical and mechanic properties) before and after the immersion. The description as follows:

### 6.1. Water test result

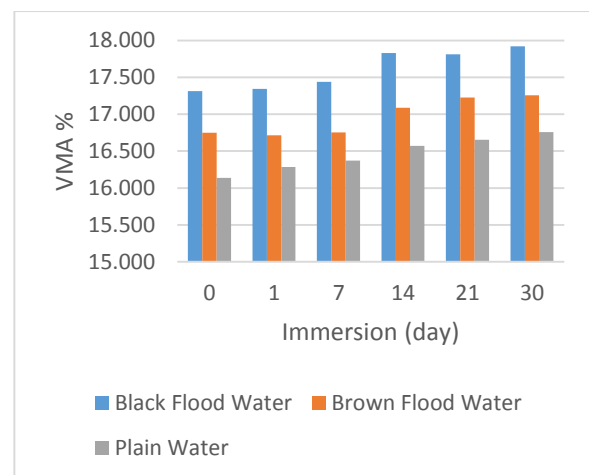
**Table 2.** Water test result.

Properties	unit	Type of Water			
		limit	Black Flood Water	Brown Flood Water	Plain Water
Ph	-	6 - 9	7.85	7.56	7.73
BOD	mg/L	60	93.9	5.2	0.3
COD	mg/L	150	313	15	1
TTS	mg/L	50	94	14	2
Sulfida	mg/L	0.3	0.103	0.010	0.001

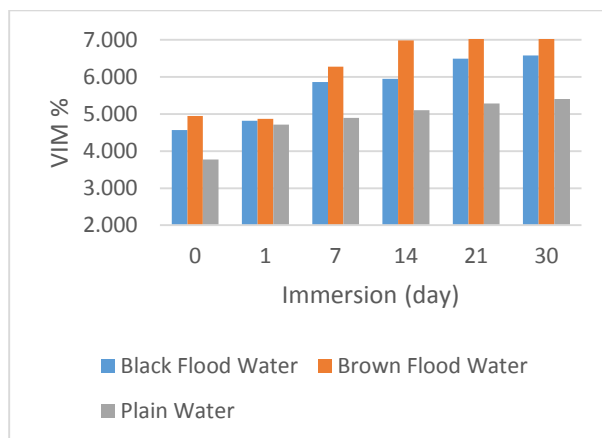
### 6.2. Result test of an Asphalt



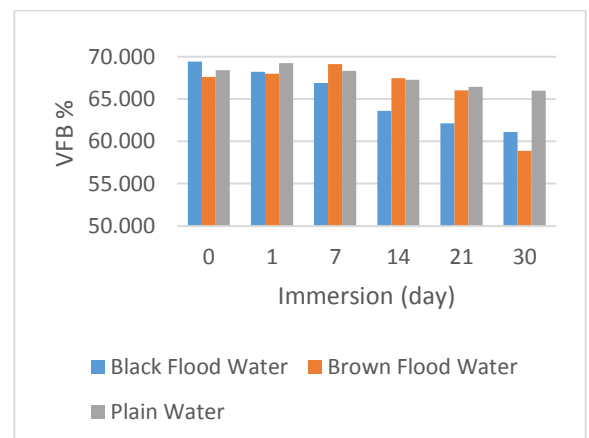
**Figure 3.** Graphic of relation density and duration of immersion.



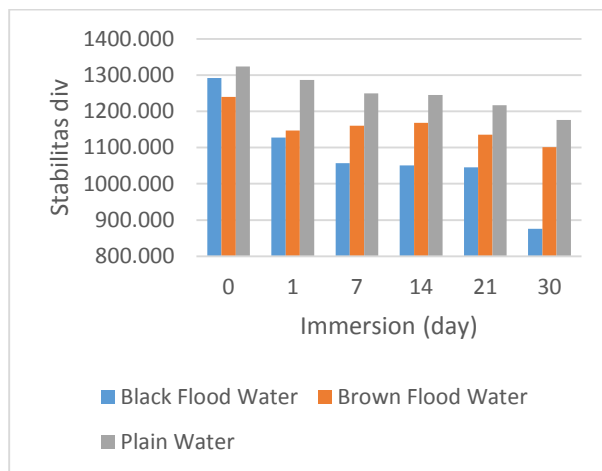
**Figure 4.** Graphic of Relation VMA % and duration of immersion.



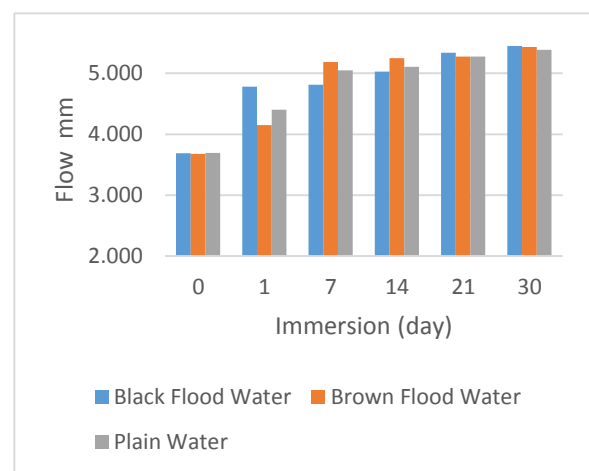
**Figure 5.** Graphic of relation VIM and duration of immersion.



**Figure 6.** Graphic of Relation VFB % and duration of immersion.



**Figure 7** Graphic of relation Stability and duration of immersion.



**Figure 8** Graphic of Relation flow and duration of immersion.

## 7. Conclusion

From the elaboration above, it may conclude that:

- The longer the asphalt mixture is submerged the density value decreases by obtained a value of density which is increasingly down to 70% for the duration of the immersion of 30 days. this is accompanied by an increase in the value of VIM which is increasingly high so that the asphalt mixture will tend to be more vulnerable to deformation and rutting.
- from the three types of water immersion, black flood water has the greatest influence on Marshall defense forces. Obtained from Marshall values up to 32.10%. Whereas for flood water the value of chocolate was 11.18% and clean water was 11.14%.
- Soaking water with high sulfate content is the most influential on asphalt mixture.

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## References

- [1] Sukarmanto H 2016 *Kajian Durabilitas Campuran Asphalt Concrete-Wearing Course (AC-WC) Terhadap Rendaman Air Banjir* (Tesis. Universitas Gajah Mada: Yogyakarta)
- [2] Nahyo N, Sudarno S and Setiadji B H 2015 Durabilitas Campuran Hot Rolled Sheet-Wearing Course (HRS-WC) Akibat Rendaman Menerus Dan Berkala Air ROB *Jurnal Teknik Sipil Unaya* **1**(2) pp 141-154
- [3] Yilmaz A and Sargin S 2012 *Water Effect on Deteriorations of Asphalt Pavements* (Duzce University: Turkey)
- [4] Hu J, Wang X and Guo R 2011 Rainfall Infiltration Influence to Asphalt Concrete Pavement *In International Conference on Computer Education, Simulation and Modeling* pp. 170-173 (Springer, Berlin, Heidelberg)
- [5] Direktorat Jenderal Bina Marga 2010 *Spesifikasi Umum Divisi 6* (BSN, Jakarta)
- [6] Adhiharta D S 2010 *Kajian Sifat Teknis Agregat Lokal di Sekitar Kabupaten Blora terhadap Durabilitas Campuran Laston* Tesis (Program Magister Teknik Sipil, Universitas Sebelas Maret Surakarta)
- [7] AASHTO 1998 *Standard Specifications for Transportation Materials and Methods of Sampling and Testing* (Washington D.C)