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Implementation device for measuring water depth at proving ground test track

Singgih Aji Wibowo[1], Dena Hendriana[2]

[1] Department of Mechanical Engineering, Swiss German University, Tangerang 15143, Indonesia
[2] Department of Mechanical Engineering, Swiss German University, Tangerang 15143, Indonesia

Abstract. Tires adhesion on the wet surface between the road surface and vehicle tires is one of the requirement from ECE Regulation No.117 for tires sold in European countries. When tested on a specified test track, tires will be tested and compared the test results with standard reference test tires (SRTT). As a result, the performance index from measured tires is given and indicated by a wet grip index (G). ECE Regulation R117 specifies the wet grip index at a level of water depth between 0.5 and 1.5 mm on the test track surface [1]. The measurements can be done using a simple 150 mm steel ruler with the graduation of 0.5 mm. Before measuring, the tip of steel ruler is polished with Kolor Kut to show the different color when ruler tip is dipped into the water perpendicularly. Then record the data for monitoring the water depth of the test track. Since ECE Regulation R117 specifies the water depth at 1.0 mm +/- 0.5 mm, then it will need a measuring device which has a graduation of less than 0.5 mm. For this reason, we develop a tool for measurements water depth which able to show measurements of one-tenth of a millimeter.

Keyword: water, depth, measuring, device, track.

1. Introduction

With referring to ECE R117 for approval tire adhesion on the wet surface. There is a requirement at General Test Conditions for wet conditions. For the surface that wetted from the track-side. The test surface shall be wetted for minimum half an hour before testing to equalize the surface temperature and water temperature [1]. It is a recommendation that track-side wetting is continuously applying throughout testing. The water depth shall be between 0.5 and 1.5 mm.

Since there is no commercial device for measuring water depth on the road surface, then there is a need to develop a Device for Measuring Water Depth [2] for use in Proving Ground Test Track.

The objective of this paper is to develop measuring device able to measure water depth on the test track at 0.5 – 1.5 mm with graduation less than 0.5mm. Then make sure the method can work appropriately by conducting water depth measurements on the test track using this device.

2. Scope

The scope of this study is limited to the development of measuring device and implementation the measurement of water depth at Proving Ground Test Track at Karawang.

3. Methodology

3.1. Measure the water depth.

To do the measurement is simple and the device easy to handle. The result can be read easily with digital display monitoring provided on the micrometer measurement tool. Connect the tool to the measurement device by using screws. By turning clockwise direction at the micrometer screw, the sensing probe will move down. If sensing probe of measurement device has touched the water film above the test track, it creates some resistance at sensing probe which then activated IC N555, and the buzzer will make sound with a LED sign shining. Once buzzer sound is heard we stop turning down the sensing probe, then the value of water depth can be read from the digital display. The contact patch of the device set at the zero level of the road surface and the measurement device also calibrated at this level of test track surface using a flat plate. Before doing the measurements, the volume of water must be positive covered or above the track surface.

The following figure illustrates road surface condition with the micro & macro textures.

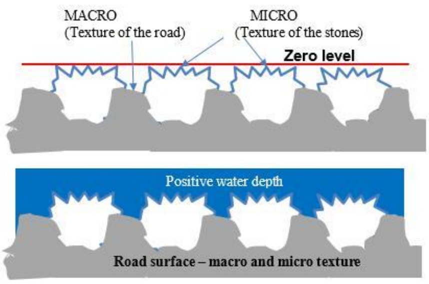


Figure 1. Zero level and Positive water depth. To do the measurements the macrotexture to make sure already covered with water. The device will measure the positive part of water depth at each measurements points, and record the result data. Water depth value is determined by averaging the test data result.

3.2. Water parameter for electrical conductivity.

Parameter electrical conductivity the water [3] used for watering the track as shown below:

Table 1. Water parameter.

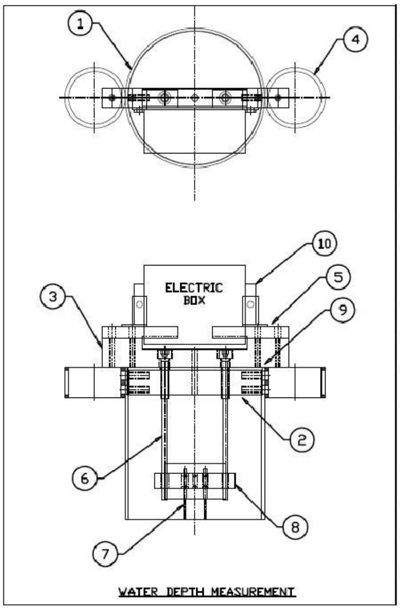
No. Sampel : 01/Lab-Eks/V/2017

Parameter	Satuan	Hasil	Standar	Metode Uji
A. FISIKA				
Rasa	-	tidak berasa	tidak berasa	IK No. 21 (Organoleptik)
Bau	-	tidak berbau	tidak berbau	IK No. 21 (Organoleptik)
Suhu *	° C	24,8***	****	SNI 06-6989.23-2005
Warna	skala PtCo	10	50	SNI 06-6989.3.80-2011
Kekeruhan *	skala NTU	3,5	25	SNI 06-6989.25-2005
Zat Padat Terlarut	mg/L	394	1500	IK No 12
Daya Hantar Listrik *	µS/cm	806	-	SNI 06-6989.1-2004
B KIMIA				
pH *	-	7,58***	****	SNI 06-6989.11-2004

For 20 mm distance of sensing probe, the conductivity < 1 second is acceptable.

3.3. Develop a measurement device.

3.3.1. Mechanical drawing



ITEM	DESCRIPTION	MATERIAL	QUANTITY	REMARKS
11	Bolt & nut	sus304	12 pcs	
10	Box holder	ss-41	1 pc	
9	Cover	Acrylic	1 pc	
8	Sensor holder	teflon	1 pc	
7	Contact pin	sus304	2 pcs	
6	Sliding L bolt	sus304	2 pcs	
5	Clamp holder	sus304	2 pcs	
4	Casing holder	sus304	2 pcs	
3	Holder	sus304	1 pc	
2	Base	sus304	1 pc	
1	Casing	sus304	1 pc	

MESSENGERS		FILENAME	
DRAWING NAME	WATER DEPTH MEASUREMENT		
DESIGNED BY		DRAWING NO.	
DRAWN BY		DATE	
CHECKED BY		SCALE	1 : 2, 1 : 3
APPROVED BY		SHEET NO.	1 OF 1

Figure 2. Design drawing for a measuring device.

The body of device and parts mainly using stainless steel as the environment of measurement are at water area. Stainless steel has properties to resist against rust.

3.3.2. Measuring Head

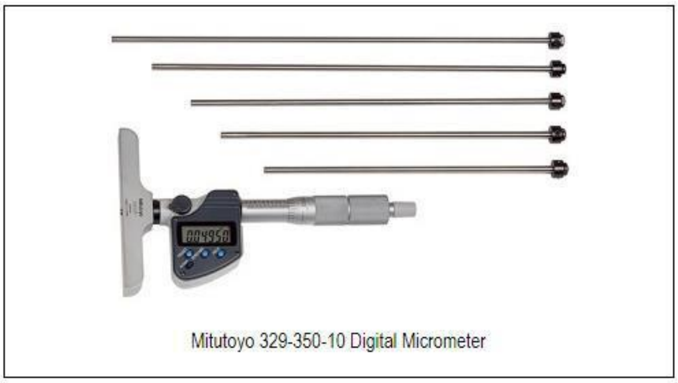


Figure 3. Mitutoyo 329-350-30 Digital Depth Micrometre [4].

For the head of measurement device use Mitutoyo 329-350-30 Digital Depth Micrometre 0-6"/ 0-150mm, 6 Rods & SPC.

Graduation: 0.01mm For this development method of measuring water depth is targeted to allow an accuracy of measurement at one-tenth of a millimeter.

3.3.3. LED Indicator.

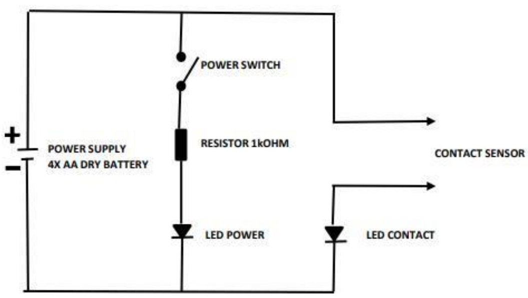


Figure 4. Electrical Circuit for LED.

To identify once both sensing probes touched the water then LED will light ON.

3.3.4. Buzzer alarm using IC NE555 [6]

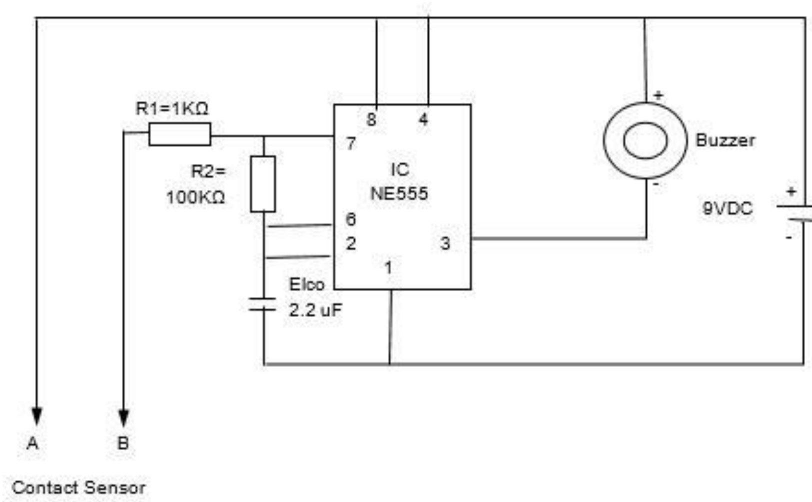


Figure 5. Electrical Circuit for buzzer.

On test track under the sun shining the LED shine may not visibly be seen. So application buzzer alarm will help the operator identify once sensing probe touched the water.

3.3.5. Picture of the measurement device after assembled

Sensing Probe of water depth device

Figure 6. Measuring device after assembled

4. Test Result

4.1. Verification on the different method of reading the measurement of water depth:
There are three methods to read the water depth:

4.1.1 Method1: Measurement Turn Down using water depth device.
Read condition at "ON" is when sensing probe touch water. The probe connected by water.

4.1.2 Method2: Measurement Turn Up using water depth device.
Read condition at "OFF" is when sensing probe leaves the water. In this case, it does not connect with the water.

4.1.3 Method3: Using a steel ruler covered with Kolor Kut water finding paste.
Kolor Kut also has known as Water Gauging Paste is used to test the water depth from the water surface to above the macrotexture. The yellow color paste is applied to the tip of steel ruler and dipped to water at test track to zero level of the macrotexture of the road. The tip of steel ruler with

the paste that touches water will immediately change color to a brilliant red when contacted. After that, we can determine the depth of the water by the Kolor Kut paste that has turned its color [5].

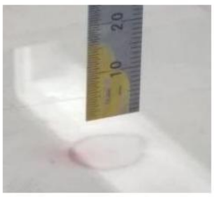
Steel Ruler 150 mm with the graduation of 0.5 mm, covered with Kolor Kut.	Kolor Kut water finding paste.
  Before dipped After dipped	

Figure 7. Steel ruler with Kolor Kut to measure the water depth.

The comparison result from the above three methods of measurement shown below table 2:

Table 2. Verification table for three ways of measuring the water depth.

Date of measurement:			7/31/2018
No	Method1	Method2	Method3
1	0.949	1.419	1.000
2	0.940	1.423	1.000
3	0.950	1.424	1.000
4	0.952	1.414	1.000
5	0.956	1.412	1.000
Minimal	0.94	1.412	1.000
Maximal	0.956	1.424	1.000
Averages	0.949	1.418	1.000
St. Dev	0.006	0.005	0.000

There is a different result for measurement result using method1 and method2 at 0.469mm (from 1.418mm - 0.949mm). Standard deviation is also small enough at 0.006 mm.
The difference caused by water capillarity when sensing probe lifting up the water still stick at the tip of sensing probe.

While from measurement result using method3 with a steel rule, by rough reading we can only read as 1 mm without any digit after the comma.

Based on the above water depth measurement result, then method1 is selected as it is the best way of measuring the water depth.

4.2 Implementation of water depth measurements at Proving Ground Test Track at Karawang.

Figure 8. The water depth measurements at Proving Ground Test Track Karawang.

Then we do a real measurement at the watering track. We compared the previous method of measuring water depth usingmethod3 above with steel rule comparing to using the measuring device withmethod1 for measurements. There are 2 tracks, track number B5 and track number B9 with 202 points measurement for each record.

See the graph comparing measurements result from different measurement methods, i.e., by using a steel ruler and measuring device using micrometer at below:

4.3. Measurement water depth at Test Track B5

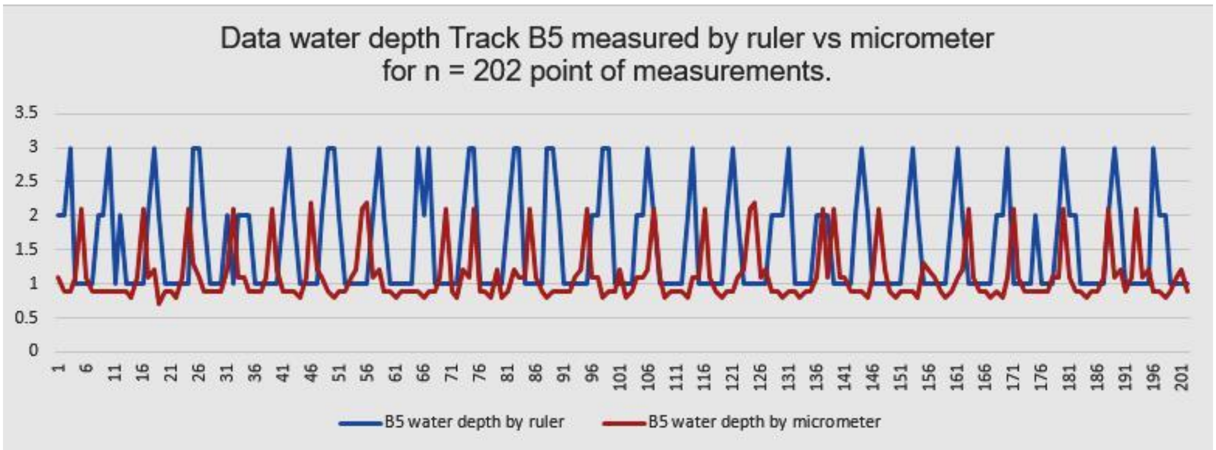


Figure 7. Graph of measurement water depth at Track B5 by using micrometer versus ruler.

4.4. Measurement water depth at Test Track B9

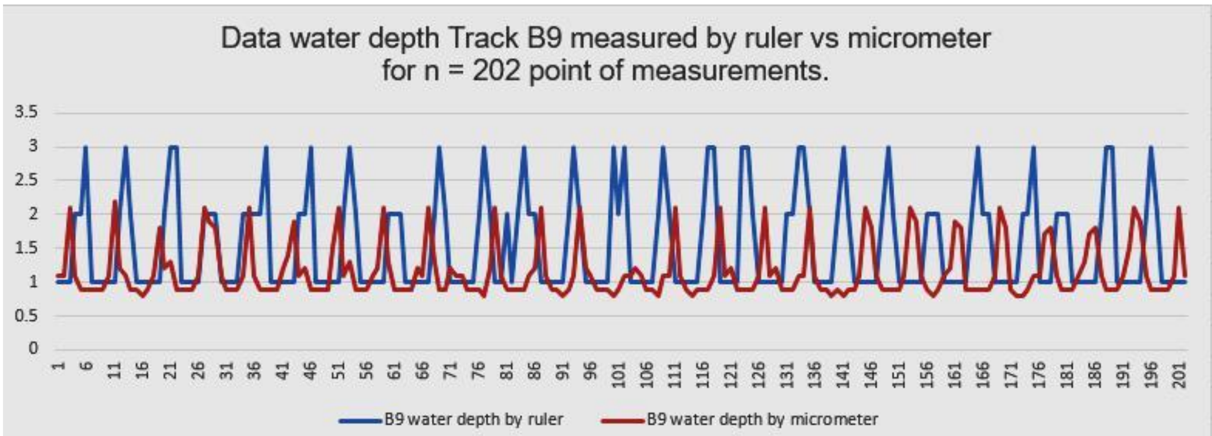


Figure 8. Graph of measurement water depth at Test Track B9 by using micrometer versus ruler.

The result data's from measurements are recorded and calculated as shown in Table 3 below:

Table 3. Water depth measurement results

Track number	B5 Track			B9 Track		
Condition	Ruler	Micrometer	Gap	Ruler	Micrometer	Gap
Date of measurement	Feb 2018	May 2018		Feb 2018	May 2018	
Minimum	1	0.7		1	0.8	
Maximum	3	2.2		3	2.2	
Averages n=202 points	1.5545	1.1119	0.4426	1.5396	1.1594	0.3802
St. dev	0.7394	0.3900	0.3494	0.7199	0.3931	0.3268

5. Conclusion

- To read water depth data with a graduation of 0.5 mm is difficult when using a steel ruler with Kolor Kut.
- While using water depth measuring device can read measurements with the graduation of one-tenth of a millimeter.
- Variation of measurements by using a measuring device can reduce the Standard Deviation of the measurements from 0.7199; 0.7394 to 0.3900; 0.3931 mm. The varieties come from measuring tool accuracy, and area coverage from measuring tools size.

6. Recommendation

- Since reading and recording the data from the track is done manually write the result on the recording sheet. It is advised to improve further in the device:
- To include wired cable data into the laptop in the field track. In order, data can read and type automatically into the computer.
- Data transfer using wireless communication which is more convenient for use.

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[6] IC NE555 datasheet.

Call for paper

The **8th Annual Conference on Management and Information Technology (ACMIT)** is a scientific conference primarily organized for MIT (Master of Information Technology). In conjunction with this conference, MME (Master of Mechanical Engineering) also organizes a conference called CMEI (Conference on Management and Engineering in Industry). The primary goal of this event is to help the students from both MIT and MME study programs to publish their papers as requirements for their graduation as ordained by the Higher Education (DIKTI) of Ministry Education regulation no. 152/E/T/2012.

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1. **Method of Submission:** All submissions must be submitted via e-mail address:

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