

Study of the relationship of asphalt modulus to the height of the laboratory LWD

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1 Study of the relationship of asphalt modulus to the height of the laboratory LWD

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Abstract. In the construction of the transportation network, road infrastructure is being developed intensively. Quality assurance is needed to prevent failure and ensure long performance. To measure the quality of road works, especially asphalt, can now use the laboratory version of the Lightweight deflectometer (LWD) tool developed by DGH. Lightweight deflectometer (LWD); which has been developed for evaluation of surface stiffness can be used to estimate the degree of compaction and produce modulus of elasticity. This a laboratory-based study aims to analyze the effect of asphalt mixture density (AC-WC) on deflection values and modulus of elasticity using laboratory version of the LWD and find the correlation between the modulus of elasticity of asphalt against variations in the height of the mashing load.

1. Introduction

There are several road network systems, one of which plays an important role is the primary arterial road network system which is a connecting road between national activity centers or between national activity centers and regional activity centers. This road network is also a road that serves the backbone of national transportation, so it is important to pay attention to maintenance to maintain the quality of road services and not become an obstacle in the smooth flow of traffic.

Good road conditions will facilitate mobility of the population in carrying out activities every day. Roads with flexible pavement and good rigid pavement must have quality for the sake and comfort of road users. Besides that, road pavement must have resistance to erosion due to traffic loads, weather changes and other adverse effects and have an ideal service life. In accordance with the Road Maintenance Manual No: 03 / MN / B / 1983 road damage is classified into; (1) Cracking, (2) Distortion, (3) Surface Defects, (4) Wearing, (5) Overweight (bleeding), (6) Decreasing in the former utility planting. In general, the damage that occurs is a combination of various types of damage as a result of various interrelated factors.

The density, deflection and elasticity of each subgrade, base layer to asphalt mix layer are important parameters for designing a road construction. Conventional tests that are usually carried out for evaluation and monitoring of road without cover are Dynamic Cone Penetrometer (DCP), direct CBR, Plate Bearing Test, etc. One of the tools to test and analyze deflection and elasticity in soil, foundation layers and asphalt mixture layers is LWD (Light-Weight Deflectometer) [1]. using LWD (Light-Weight Deflectometer) to analyze the deflection and resilient modulus of subgrade coated with



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various surface materials, namely recycled material from asphalt and which are stabilized with conventional natural aggregates [2], using LWD to test laterite soil elasticity that has been peeled 30 cm deep. The elasticity of laterite soils based on LWD is between 25 MPa to 200 MPa.

In this study to find out how the level of damage that occurs at the above study location based on the age of the plan, it is necessary to make a visual observation then an analysis of the pavement condition index is the level of the pavement surface conditions that occur. The pavement condition index analysis is performed using a LWD (Light Weight Deflectometer) tool to determine deflection that occurs in the segment.

The important thing in the management of a road pavement system is the ability to determine the current condition of a road network, and estimate its condition in the future. To predict pavement conditions properly, an assessment method for identification must be used. This system is a tool for appraisal personnel in assessing pavement damage. The pavement condition evaluation system or method consists of Dirgolaksono Mochtar Method and Bina Marga method. This method is often used to assess road pavement conditions. But at this time, commonly used LWD (Light Weight Deflectometer) tool to determine the magnitude of deflection that occurs on pavement roads.

Therefore, the frequency of quality control tests can be increased which leads to an improvement in the overall quality of compacted pavement layers. This research aims to :

1. Analyzing the effect of density, moisture content and asphalt content of asphalt mixture (AC-WC) on deflection values and modulus of elasticity using laboratory version of LWD.
2. Analyzing the correlation between the modulus of elasticity produced by the laboratory version of the LWD against the height of the fall in the laboratory LWD load.

2. Literature Review

2.1. Voltage and Strain Value

The loading process that is carried out continuously on a material will produce stress and the implication is to produce strain. Stress is the intensity of the reaction load at each point in the material imposed by the service load or plan load, service life of the pavement, assembly conditions, fabrication, and thermal changes or temperature changes that occur in the material [3].

Stress (stress) states the amount of the maximum load that can be received on the cross-sectional area of an object, or it can be said that the force acting is proportional to the length of the object and inversely proportional to the area of its appearance.

In the pavement layer, the traffic load that passes through the pavement layer can cause compressive stress, namely in the upper layer, as well as tensile stress in the lower layer as shown in Figure 1. The stresses are expressed in equation 1.

$$\sigma = \frac{F}{A} \dots \dots \dots (1)$$

When :

σ = Stress (MPa)

F = Force (N)

A = Luas penampang (mm²)

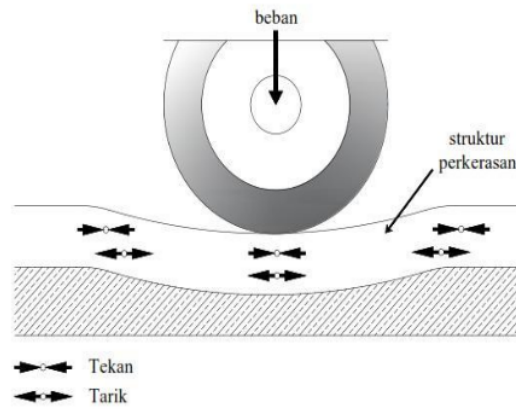


Figure 1. Stress that occurs in the pavement layer [4].

Strain states relative deformation due to stress (tensile or compressive) [5]. The strain value is obtained from the comparison between the magnitude of the dimensional changes (ΔL) that occur due to the initial dimensions (L_0), or is written in equation 2.

$$\epsilon = \frac{\Delta L}{L_0} \dots \dots \dots (2)$$

Dimana :

- ϵ = Strain (mm)
- ΔL = Distance long (mm)
- L_0 = Long 0 (mm)

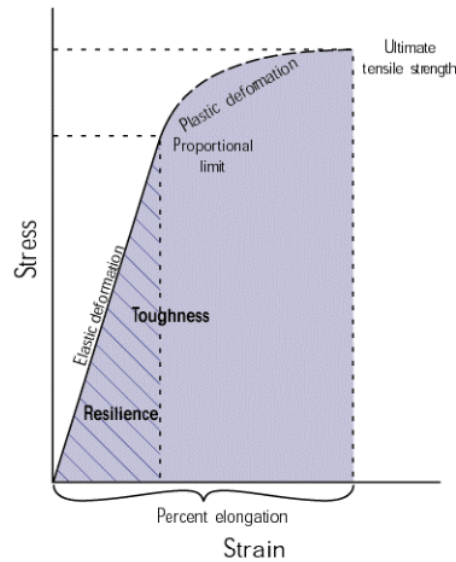


Figure 2. Stress-strain diagram.

2.2. *Research Framework*

Modeling laboratory LWD tools is based on concepts from field LWD tools that are simplified so that they can be used in laboratories and the results obtained are the same as field LWD tools. By using deflection data, which is usually called a deflection bowl, the stiffness of the pavement-forming layer can be determined from a countdown, using computer programs. Figure 3 shows the research framework.

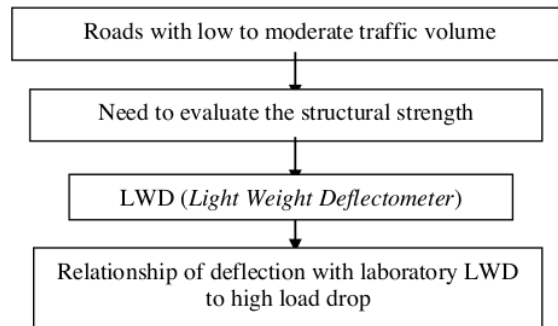


Figure 3. Research framework

3. **Research Methods**

3.1. *Research Location and Time*

This research was conducted at the Eco Material Research Laboratory Department of Civil Engineering, Faculty of Engineering, Hasanuddin University, Gowa, South Sulawesi. The time of the study was conducted in June 2019 until October 2019.

3.2. *Research Instruments*

Basically, the working principle of the laboratory LWD is the same as the LWD tool in the field, which is an instrument that can measure deflection value and modulus of elasticity through load impulses arising from a load with a certain weight dropped at a certain height on a plate surface with a certain area on a pavement surface that is will cause deflection that is measured using a displacement sensor. The difference lies in the sensor used. In the field LWD, the sensor used is geofone while in the LWD the laboratory uses an accelerometer type MEMS *Accelerometer*. To evaluate the LWD equipment produced then the Marshall test specimens were made using a mixture of AC-WC.

3.3. *Data analysis method*

The method of data analysis using laboratory LWD tools is the same principle as analyzing data using field LWD tools, namely computerized systems. Based on Bousinnesq elastic, the relationship between pressure and displacement applied in the soil for the case of rigid or flexible bases located in a semi-elastic space can be derived as in equation 3.

$$E = \frac{(1 - \nu^2) \times \sigma_0 \times a}{d_0} \times f \dots\dots\dots(3)$$

When:

- E = Modulus of elasticity (MPa)
- d0 = Measured decrease (mm)
- ν = Rasio Poisson
- σ0 = Applied Strain (MPa)
- a = Plate radius (mm)
- f = Factor

4. Expected results

The expected results of the research to be carried out are obtain a correlation between the modulus of elasticity produced by the laboratory version of the LWD against the height of the fall in the laboratory LWD load.

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