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MULTILAYER TESTING EXPERIMENTAL STUDY ON PAVEMENT MADE OF POROUS ASPHALT AND CONCRETE

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ABSTRACT

The word Multi layer has a broad spectrum that has been widely used by various discipline is science, specifically in the pavement (eg pavement) has been used as a medium that provides theoretical information regarding the response of pavement layers. Multi layer as a concept has been used as an approach in the planning of thick layers of added pavement as the main principle of the mechanistic method, and become part of the method of artificial neural network, multi-layer also has been used as part of the analysis of pavement computerization with specific loading models. for this study as a sort of multi-layer testing of its own with a literature review, experimental. A literature review using internalization-adduct approach. Experimental study of wear approach to results-mechanistic empirical methods modification, literature review and analysis results are validated experimentally using software Bisar 3. The final results of the study into consideration policy makers on road maintenance management stages for the implementation of the pavement structure is integrated and synergistic with the performance of the pavement structure.

Keywords: multi layer, literature review, experimental study, validity, pavement performance.

INTRODUCTION

Pavement is usually used in the construction of parking terminals, offices, campuses, schools, houses of worship, shopping centers and housing sites; airport runway construction and road construction [4]. All construction is made of pavement as a major part of the construction. In general, construction of pavement pavement divided into three types, namely: flexible pavement, rigid pavement and pavement composites, where the pavement composite is a combination of flexible and rigid pavement [14].

Talk about the pavement inseparable pavement performance. Performance capability of pavement can be seen from the pavement (pavement responses) receives load acting on it. Every time loading him, there will be deformation. If the charge / chargeng excessive then layered pavement structure will lose its power and when the incident happened in a long time and repeatedly then cause problems such functional safety and comfort and structural problems such as a wave or cracks which will continue to collapse / failure / damage early on construction [17]. Therefore, after the design before construction should be considered for new testing (ide testing of name ideas offer multi-layer testing) were allegedly able to provide new information for policy makers to be continued or not a result of the design. Therefore, it should be understood that the multi-layer test is intended to test the results of an existing design before the design is not implemented in the field, and also not the case settlement studies. Also it is important to prove that the multi-layer testing can provide information on the results of the design being tested. Despite such a manner desired, but because the investigation is carried out not commonly used in the manufacture of the test object in the two spectrum empirical circumstances. (covered and uncovered)

It is known that the practices were carried out during this time is simply relying on the results of the design (either the material or a model construction) and supervision of the implementation on the ground in the hope of what is being implemented does not deviate from the design, it turns out anything like this still has not been able to reduce premature failure on the construction [17]

Also realized that there has been no form of previous testing that is similar to the spectrum covered showing that "the addition of a layer of concrete and asphalt can increase the load destroyed and reduce deflection occurs and reduces the voltage that occurs in the subgrade due to the expenses incurred on the surface of the pavement structure" Tjaronge Wihardi, M, Herdiman Indra (2015) [14]. From the results of this study suggested that it happened because the specimen restrained by a rigid wall.

Therefore, in this study will be tested multi-layer on the spectrum covered (use a box of steel wall elastic) and open (located freely without the box) that is assumed will provide / add information on the construction of pavement (prior to the construction of pavement) as structural pavement observed that the composite pavement (concrete and porous asphalt) where concrete as a base course and asphalt surface of the porous layer, which both placed on the basis of clay soil..

Boussinesq theoretical results [14] and theoretical Westergaard [14] [7] on both spectra can be seen in Table-1.

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Table-1 Calculated vertical soil stress, deflection and surface stress Boussinesq And Westergaard Equation

Closed Spectrun			Open Spectrun			Explanation
Load (kN)	Depth (Cm)	Vertical Soil Stress (MPa)	Load (kN)	Depth (Cm)	Vertical Soil Stress (MPa)	
126,78	20	0,122	111,12	20	0,107	Calculated Boussinesq equation
	40	0.101		40	0.089	
	Deflection (Cm)	Surface Stress (MPa)		Deflection (Cm)	Surface Stress (MPa)	
	1,51	3,157		1.32	2.769	Calculated Westergaard equation
	1,99	3,051		1,74	2,674	Westergaard modification[a]

Source: Result calculated 2015
[a]Comulative elasticity modulus concrete and porous asphalt

MATERIALS AND METHODS

Dimension material tested

Configuring the composition of the surface layer in the form of porous asphalt, cement concrete form foundation layer, a layer of subgrade in the form of closed and open spectrum [13]. Both spectrum and three-dimensional illustrations as shown in Figure-1.

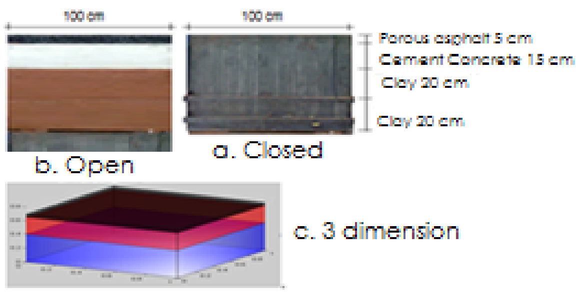

Figure-1. Configuration specimen spectrum.

Laboratory tested

Tests on the pavement structure both spectra with static loading monotonic simultaneously using a set of test tools in the form of a steel frame, medium steel plate (conditions covered and uncovered), hydraulic jack / compression machine, load cell, strain gauge concrete, strain gauge asphalt, LVDT / Linear vertical differential transducer, transducer soil), as well as the data logger and a computer station along with the program, as shown in Figure-2 below.

Figure-2. Setup for multi layer static monotonic loading testing.

Through the compression engine along with a load cell capable of providing Axis Load continuously at a steady pace on the surface of the pavement (to uncover all the events of all road pavement layer structure simultaneously, the surface layer and the base layer and subgrade).

RESULTS AND DISCUSSIONS

Results of study on the spectrum with monotonic static loading models only viewpoint was interior position value table maximum condition (when the load is stagnant), while the graph gives an overview on all conditions. on the relationship between the behavior of the load, deflection and surface stress; the relationship between the behavior of the load, the vertical stress and the subgrade. The test results in the second test specimen spectrum described as follows:

Result closed spectrum

Result obtained deflection testing tabulated Table-2 measured deflection of specimen.

Table 2 Measured deflection of specimen

Maximum Load (kN)	Deflection						Rate of deflection (mm)
	L1 (mm)	L2 (mm)	L3 (mm)	L4 (mm)	L5 (mm)	L6 (mm)	
126,78	4,93	10,55	9,59	16,78	9,51	12,32	0,46

Table-2 shows that the decline simultaneously and varied in composite plates (porous asphalt concrete slab +). The average decline that occurred in the composite plate angle of 10:46 mm, while in the central region decreased on average greater is 10.91 mm. This shows that the central region occurs deflection composite plate is 0.46 mm. Correlation of both can be observed through graphs the relationship between load and deflection which occur in Figure-3.

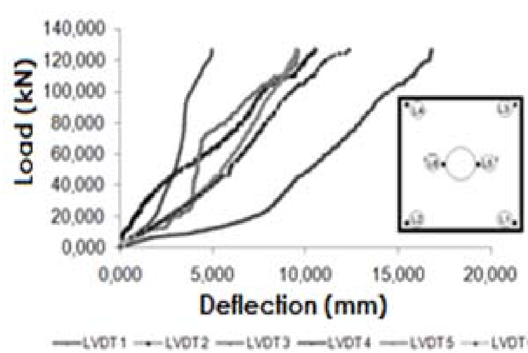

Figure-3. Load relation and deflection.

The Result of testing and calculation of surface stress according to Table-3.

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Table-3. Calculated surface stress.

Maximum Load (kN)	**Surface stress** (MPa)
126,78	2,58

Correlation Load and is directly proportional to the surface stress, it can be observed through a graph of load, deflection that occurs in Figure-4.

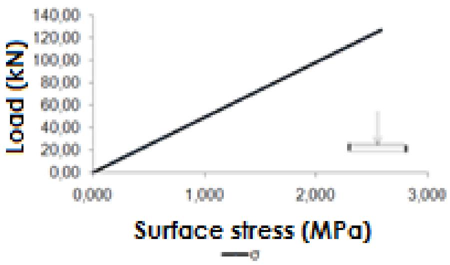

Figure-4. Load relation and surface stress.

While the connection surface stress and soil stresses looks as follows:

Table-4. Calculated surface stress and measured soil stresses under static monotonic load.

Maximum surface stress (Mpa)	Soil stresses (MPa)	
	Soil Pressure Gauge Vertical	Soil Pressure Gauge Horizontal
2,58	0,12728 0,10560	0,01680 0,00440

Table-4 shows the surface stress value of 2.58 MPa. Soil stress at a depth of 20 cm, stress soil vertical direction is read by the pressure transducer soil of 0.127 MPa and at a depth of 40 cm, stress soil vertical direction is read by soil pressure transducer at 0.106 MPa. The value of the relationship of surface stress and vertical soil stress is shown in Figure-5. Horizontal soil stress at a depth of 20 cm read by soil pressure transducer at 0.017 MPa and at a depth of 40 cm read by soil pressure transducer at 0.004 MPa. The value of surface stress relations and horizontal soil stress is shown in Figure-6.

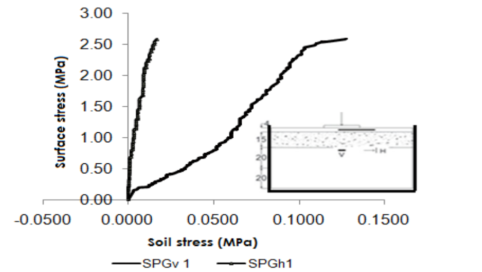

Figure-5. Surface stress relation and vertical soil stress, at 20 cm depth.

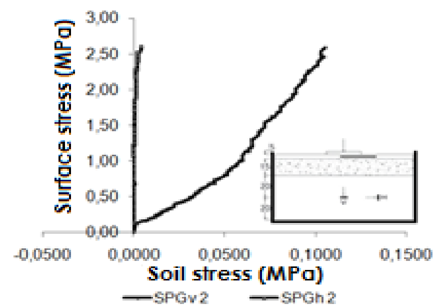

Figure-6. Surface stress relation and vertical soil stress, at 40 cm depth.

Further testing of the open spectrum Result described as follows:

Result open spectrum

Result obtained deflection testing tabulated Table-5.

Table-5. Measured deflection of specimen.

Maximum Load (kN)	Deflection						Rate of deflection (mm)
	L1 (mm)	L2 (mm)	L3 (mm)	L4 (mm)	L5 (mm)	L6 (mm)	
111,12	3,97	8,02	7,69	14,92	8,92	10,49	1,06

Table-5 shows that a decline simultaneously on the composite plate, the average decline in the composite plate corner area of 8.65 mm and in the central regions of composite plates decreased on average greater that 9.71 mm. This shows that the central region occurs deflection composite plate is equal to 1.06 mm. Charts the relationship between load and deflection which occur can be seen in Figure-7.

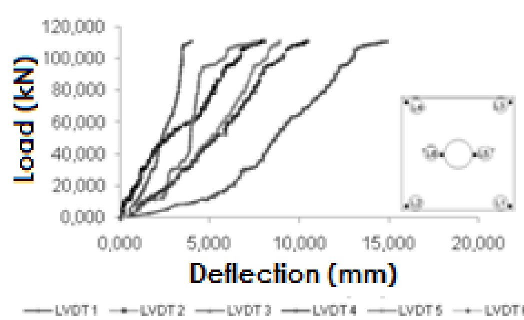

Figure-7. Load relation and deflection.

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The Result of testing and calculation of surface stress according to Table:

Table-6. Calculated surface stress.

Maximum Load (kN)	**Maximum stress** (MPa)
111,12	2,26

Correlation Load and is directly proportional to the surface stress, it can be observed through a graph of load, deflection that occurs in Figure-8.

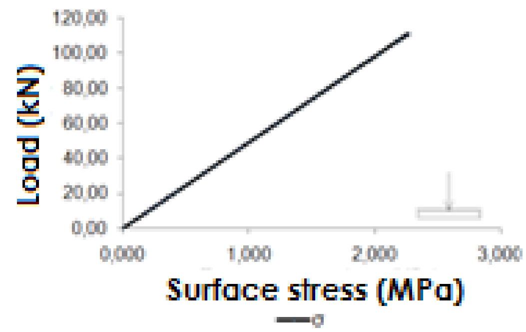

Figure-8. Load relation and surface stress.

While the connection surface stress and soil stresses looks as follows:

Table-7. Calculated surface stress and measured soil stresses under static monotonic load.

Maximum surface stress (MPa)	**Soil stresses** (MPa)	
	Soil pressure Gauge vertical	**Soil pressure Gauge horizontal**
2, 26 Table-9. Result hitungan tegangan permukaan dan pengujian tegangan tanah benda uji closed spectrum	0,09804	0,00354
	0,02916	0,00185

Table-7 shows the surface stress value of 2.26 MPa. Soil stress at a depth of 20 cm, stress soil vertical direction is read by the pressure transducer soil of 0, 098 MPa and at a depth of 40 cm, Soil stress vertical direction is read by soil pressure transducer at 0.029 MPa. The value of the relationship of surface stress and vertical soil stress is shown in Figure-9. Horizontal soil stress at a depth of 20 cm read by soil pressure transducer at 0.0035 MPa and at a depth of 40 cm read by soil pressure transducer at 0.00185 MPa. The value of surface stress relations and horizontal soil stress is shown in Figure-10.

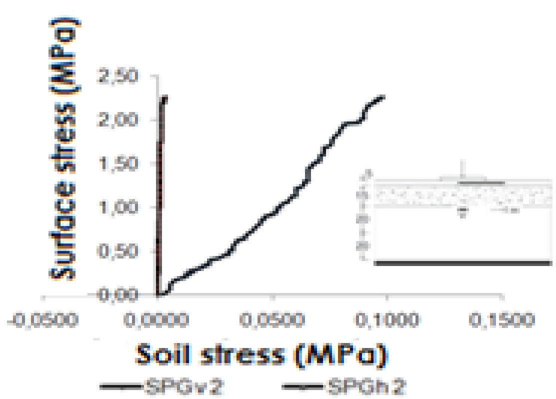

Figure-9. Surface sress relation and vertical soil stress, at 20 cm depth.

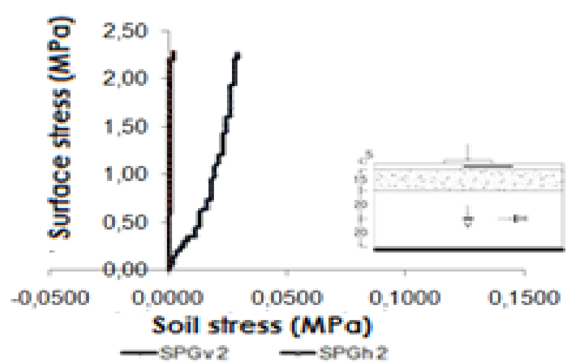

Figure-10. Surface stress relation and vertical soil stress, at 40 cm depth.

Validation with Bisar 3

Of course Bisar 3 obtained as follows:

Tabel-8. Surface stress.

Closed spectrum			Open spectrum		
	Load	Tegangan		Load	Tegangan
Number	Vertical	Vertical	Number	Vertical	Vertical
Load	(kN)	(MPa)	Load	(kN)	(MPa)
1	126.8	2.583	1	111.12	2.264

Table-9. Pavement stresses under static monotonic load.

					Closed spectrum			Open spectrum		
							Stresses			
No	Pavement Layer	X (m)	Y (m)	Depth (m)	XX (MPa)	YY (MPa)	ZZ (MPa)	XX (MPa)	YY (MPa)	ZZ (MPa)
1	Porous asphalt	0	0	0	-0.003737	-0.003737	0	-0.003275	-0.003275	0
2	Porous asphalt	100	100	25	-0.004772	-0.004772	0.00001374	-0.004183	-0.004183	0.00001204
3	Porous asphalt	200	200	30	-0.0071	-0.0071	0.00001263	-0.006223	-0.006223	0.00001107
4	Porous asphalt	300	300	50	-0.00871	-0.00871	0.001028	-0.007634	-0.007634	0.0009009
5	Concrete	350	350	150	1.362	1.362	-0.0489	1.194	1.194	-0.04286
6	Concrete	500	500	200	7.843	7.843	-0.06496	6.874	6.874	-0.05693
7	Clay	650	650	300	0.0002522	0.0002522	-0.04367	0.000221	0.000221	-0.03828
8	Clay	750	750	400	0.0002524	0.0002524	-0.03262	0.0002212	0.0002212	-0.02859
9	Clay	850	850	450	-0.0000343	-0.0000343	-0.02609	-3.006E-05	-0.00003006	-0.02286
10	Clay	900	900	500	0.00001526	0.00001526	-0.02291	0.00001338	0.00001338	-0.02008
11	Clay	950	950	550	0.00004226	0.00004226	-0.02019	0.00003704	0.00003704	-0.01769
12	Clay	1000	1000	600	0.00005275	0.00005275	-0.01785	0.00004624	0.00004624	-0.01564

Source: Result From Bisar 3.

Table-10. Pavement deflection under static monotonic load.

					Closed spectrum			Open spectrum		
							Deflection			
No	Lapisan Perkerasan	X (m)	Y (m)	edalama (m)	XX (mm)	YY (mm)	ZZ (mm)	XX (mm)	YY (mm)	ZZ (mm)
1	Porous asphalt	0	0	0	0.04176	0.04176	-0.7159	0.0366	0.0366	-0.6274
2	Porous asphalt	100	100	25	0.03422	0.03422	-0.7853	0.02999	0.02999	-0.6883
3	Porous asphalt	200	200	30	0.03155	0.03155	-0.8555	0.02765	0.02765	-0.7498
4	Porous asphalt	300	300	50	0.02189	0.02189	-0.9233	0.01919	0.01919	-0.8093
5	Concrete	350	350	150	-0.006722	-0.006722	-0.9588	-0.005892	-0.005892	-0.8404
6	Concrete	500	500	200	0	0	-1.007	0	0	-0.8829
7	Clay	650	650	300	0.019	0.019	-0.8791	0.01665	0.01665	-0.7705
8	Clay	750	750	400	0.02568	0.02568	-0.7751	0.02251	0.02251	-0.6793
9	Clay	850	850	450	0.03042	0.03042	-0.7066	0.02666	0.02666	-0.6193
10	Clay	900	900	500	0.03204	0.03204	-0.6645	0.02808	0.02808	-0.5824
11	Clay	950	950	550	0.03329	0.03329	-0.6257	0.02918	0.02918	-0.5484
12	Clay	1000	1000	600	0.03421	0.03421	-0.59	0.02998	0.02998	-0.5171

Source: Result From Bisar 3.

The results in Tables 8, 9 and 10 and show the relationship behaviors synchronization results and performance of the pavement structure, or in other words proved some parameters obtained simultaneously in a multi-layer testing does not keep away from the theoretical results and the results Bisar 3.

CONCLUSIONS

Multi layer worth increased to testing his theory because the device is clear. Multi layer worthy of testing because it meets the context of input-process-input and assumptions. Approach - an addition, result comparation and validation strengthens the argument that the multi-layer deserves to be considered a separate test able to provide information to policy makers.

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