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# Road Pavement Damage Caused By Traffic Segment: Road of Governor Soebardjo

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**Abstract** - Traffic volume and vehicle load are one of the causes of road damage. The research was conducted on Road of Governor Soebardjo. The research objective was to determine the effect of traffic volume and standard loads on road damage. The method used is the method of regression analysis and correlation. This method is to obtain the relationship between traffic volume and standard load (equivalent single axle load/ESA) on road damage with r and Pvalue values. The results of the study show a relationship between traffic volume and standard weight on road damage. The analysis yields the equation  $y = 6E-07x^2 + 0.0038x + 0.3849$  with a very strong correlation with the r value of 0.9178. Heavy vehicles significantly damage the road compared to light vehicles, it can be seen from the Pvalue which is less than 0.05. Analysis of the standard load (ESA), road damage has a very strong correlation with an r value of 0.9073 with the equation  $y = 2.4274.e6E-05X$ .

Keywords: road damage, regression, traffic, vehicle volume, standard load

## 1. INTRODUCTION

The increased load affects the transportation needs which will increase the transportation needs. So it is necessary to support transportation infrastructure in a proper condition. Governor Soebardjo Street is one of the alternative connecting roads between the city of Banjarmasin and the city of Banjarbaru. On Jalan Governor Soebardjo, it is also close to the Trisakti Port, causing many heavily loaded vehicles pass through the road. The impact of this activity results in the possibility of the load received by the road exceeding the design load (overloading) [1]. Cause damage to the road being traversed so that it needs repairs so that the accident rate is reduced and makes it easier for road users to travel. Damage repair can be repaired according to the damage that has occurred, and the right repair is to repair, close and then carry out routine maintenance [4]. The research aims to obtain a relationship between traffic volume, standard load (ESA), and the value of road damage to road damage on Road of Governor Soebardjo.

The research was conducted on Road of Governor Soebardjo which is located in the city of Banjarmasin. In research the road is divided into 8 segments according to road damage.

## 2. LITERATURE REVIEW

Road that we have met until now, is the result of discoveries and developments from human civilization. Roads can be distinguished as flexible pavements, rigid pavements and composite/ composite pavements [17]. Based on Indonesian Highway Capacity Manual (IHCM) [7], vehicles that cross the road consist of:

a. Light vehicles (LV) consist of passenger cars, pickups, minibuses, pick-ups, and small trucks).

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- b. Heavy Vehicles (HV) consist of buses, 2 axle trucks, 3 axle trucks and combination trucks.
  - c. Motorcycles (MC) consists of motorcycles and 3-wheeled vehicles.
  - d. Non-motorized vehicles (UM) such as bicycles, rickshaws, horse carriages and strollers.

Road damage consists of several types, such as alligator cracks, corrugation, depression, edge cracking, joint reflection cracking, lane, longitudinal and transverse cracking, patching, potholes, rutting, shoving, bleeding, block cracking, and slippage cracking [16].

This road damage can be assessed based on the Procedures for Developing a City Road Maintenance Program, Indonesia [6] as shown in Table 1. Based on this road damage assessment, road maintenance can be carried out such as routine maintenance, periodic maintenance, rehabilitation, and reconstruction [10]

Tabel 1  
Value of Road Conditions Based on the Type of Damage Procedures for  
Developing a City Road Maintenance Program, Indonesia

<b>Cracking</b>	
Type	Number
Alligator	5
Random	4
Transverse	3
Longitudinal	1
None	0
Depth	Number
>2 mm	3
1 - 2 mm	2
<1 mm	1
None	0
Damage Area	Number
>30%	3
10 - 30%	2
<10%	1
None	0
<b>Rutting</b>	
Depth	Number
>20 mm	7
11 - 20 mm	5
6 - 10 mm	3
0 - 5 mm	1
None	0
<b>Patching and Potholes</b>	
Area	Number
>30%	3
20 - 30%	2
10 - 20%	1
<10%	0
<b>Roughness</b>	
Type	Number
Disintegration	4
Grain release	3
Rough	2
Fatty	1
Close Texture	0
<b>Depression</b>	
Depth	Number
>5/100 m	4
2 - 5/10 m	2
0 - 2/100 m	1
None	0

Regression method analysis usually uses the value of  $r$  and  $Pvalue$ . , According to Mon [12] et al. [11] test the significance if the value ( $Pvalue$ ) < 0.05 means that the independent variable affects the dependent variable, but if the value ( $Pvalue$ ) > 0.05 then the independent variable does not affect the dependent variable. According to Radam et al. [14], the interpretation of the  $r$  value for the strength of the correlation is seen in Table 2.

Table 2 (r) Value Based on Correlation Coefficient

R <sup>2</sup> Value	The absolute value of the correlation coefficient ( r )	Interpretation
< 0.04	0.00 – 0.199	Slight correlation; almost negligible relationship
0.04	0.20 – 0.399	Low correlation; relationship is sure but small
0.16	0.40 – 0.699	Moderate correlation; substantial relationship
0.49	0.70 – 0.899	Strong correlation; marked relationship
0.81	0.90 – 1.000	Very strong correlation; very reliable relationship

**3. METHOD**

In research, data collection in the field uses the Directorate General of Highways of Indonesian method [5]. The steps taken are as follows:

1. Identification of Problems
2. Retrieving traffic volume data and road damage data. Traffic volume data is taken for 12 hours on one of the segments. Then the data becomes a benchmark for other segments whose data is taken for 2 hours.
3. Determine the value of road damage. The following table determines the value of road damage.
4. Calculating the total value of road damage to get the road condition value. The following table determines the value of road conditions.

5. Determine the priority order score. Score can be calculated by the following formula:

6. Determine the relationship between traffic volume, standard load (ESA) and the value of road damage to road damage using the regression method.

**4. RESULTS AND DISCUSSION**

**Traffic Volume**

The traffic volume on the eight segments observed is as shown in Table 3.

Table 3. Traffic Volume

Transportation type	Seg. 1	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Seg. 6	Seg. 7	Seg. 8
Van	809	1343	1566	858	905	1120	1010	1006
Public transportation	46	0	0	0	21	5	0	0
Small Bus	10	0	0	0	16	0	0	16
Big Bus	7	11	2	7	11	7	6	4
Pickup	1093	1619	818	1068	739	782	583	661
Truck 2 as 4 wheel	593	377	292	217	200	316	425	76
Truck 2 as 6 wheel	1040	923	1092	641	1191	2382	1478	1247
Truck 3 as	172	373	390	52	362	536	417	396
Truck 4 as	75	38	57	8	23	268	115	35
Trailer	126	193	488	133	104	329	225	72
Motorcycle	3632	3986	3558	2899	4797	4537	5459	5571
Motorcycle 3 wheel	0	5	0	20	0	0	0	0
Bycycle/ rickshaw, cart	20	0	0	20	40	40	60	220
<b>Total</b>	<b>7623</b>	<b>8866</b>	<b>8263</b>	<b>5923</b>	<b>8409</b>	<b>10323</b>	<b>9777</b>	<b>9302</b>

From the volume data above, convert it into pcu/hour by multiplying the passenger car equivalent (pce). The value of pce used is pce based on the Indonesian Highway Capacity Manual (IHCM) 1997 [7].

The traffic load is obtained from the traffic volume converted to a standard load (Equivalent Single Axle

Load, ESA) using the Vehicle Damage Factor (VDF). The VDF value is based on the Road Pavement Design Manual (RPDM), 2017 [8] as shown in Table 4.

Table 4 VDF Value of Commercial Vehicle (RPDM, 2017)

Jenis kendaraan	Sumatera				Jawa				Kalimantan				Sulawesi				Bali, Nusa Tenggara, Maluku dan Papua				
	Beban aktual		Normal		Beban aktual		Normal		Beban aktual		Normal		Beban aktual		Normal		Beban aktual		Normal		
	VDF 4	VDF 5	VDF 4	VDF 5	VDF 4	VDF 5	VDF 4	VDF 5	VDF 4	VDF 5	VDF 4	VDF 5	VDF 4	VDF 5	VDF 4	VDF 5	VDF 4	VDF 5	VDF 4	VDF 5	
5B	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0
6A	0,55	0,5	0,55	0,5	0,55	0,5	0,55	0,5	0,55	0,5	0,55	0,5	0,55	0,5	0,55	0,5	0,55	0,5	0,55	0,5	0,5
6B	4,5	7,4	3,4	4,6	5,3	9,2	4,0	5,1	4,8	8,5	3,4	4,7	4,9	9,0	2,9	4,0	3,0	4,0	2,5	3,0	3,0
7A1	10,1	18,4	5,4	7,4	8,2	14,4	4,7	6,4	9,9	18,3	4,1	5,3	7,2	11,4	4,9	6,7	-	-	-	-	-
7A2	10,5	20,0	4,3	5,6	10,2	19,0	4,3	5,6	9,6	17,7	4,2	5,4	9,4	19,1	3,8	4,8	4,9	9,7	3,9	6,0	6,0
7B1	-	-	-	-	11,8	18,2	9,4	13,0	-	-	-	-	-	-	-	-	-	-	-	-	-
7B2	-	-	-	-	13,7	21,8	12,6	17,8	-	-	-	-	-	-	-	-	-	-	-	-	-
7C1	15,9	29,5	7,0	9,6	11,0	19,8	7,4	9,7	11,7	20,4	7,0	10,2	13,2	25,5	6,5	8,8	14,0	11,9	10,2	8,0	8,0
7C2A	19,8	39,0	6,1	8,1	17,7	33,0	7,6	10,2	8,2	14,7	4,0	5,2	20,2	42,0	6,6	8,5	-	-	-	-	-
7C2B	20,7	42,8	6,1	8,0	13,4	24,2	6,5	8,5	-	-	-	-	17,0	28,8	9,3	13,5	-	-	-	-	-
7C3	24,5	51,7	6,4	8,0	18,1	34,4	6,1	7,7	13,5	22,9	9,8	15,0	28,7	59,6	6,9	8,8	-	-	-	-	-

The ESA values for various types of vehicles can be seen in Table 5.

Tabel 5. ESA Value of Each Type of Vehicle

Segment	6A	6B	7A	7C	ESA
1	593	1040	172	201	16385
2	377	923	373	230	19548
3	292	1092	390	545	27680
4	0	641	52	141	9286
5	200	1191	362	127	19439
6	316	2382	536	598	42402
7	425	1478	417	340	27346
8	76	1247	396	106	20054

**Road Damage**

The value of road damage for each segment is shown in Table 6.

Table 6. Value of Road Damage

Segment	Skor Road Damage
1	8
2	11
3	9
4	2
5	11
6	22
7	9

To analyze road damage in several segments, it is best if the conditions of all segments are the same, especially the road structure. Eight segments were observed in the study, by analyzing the traffic volume of light vehicles (LV), heavy vehicles and average daily traffic (ADT). As in Table 7.

Table 7 Variable Recapitulation

No.	Damage Score	LV (pcu/hour)	HV (pcu/hour)	ADT (pcu/hour)
1	8	2551	1420	4397
2	11	3340	1536	5336
3	9	2142	2029	4780
4	2	1933	835	3018
5	11	1881	1691	4079
6	22	2224	3523	6803
7	9	2017	2241	4930
8	8	1759	1753	4037

4 The relationship between independent variables and dependent variables, namely between the damage score and the type of vehicle LV, HV and ADT in Figure 1, Figure 2 and Figure 3 below.

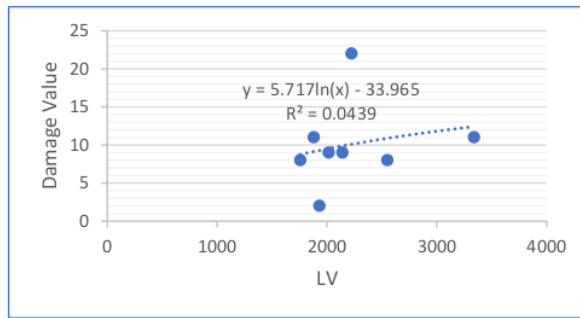


Figure 1 LV and Damage

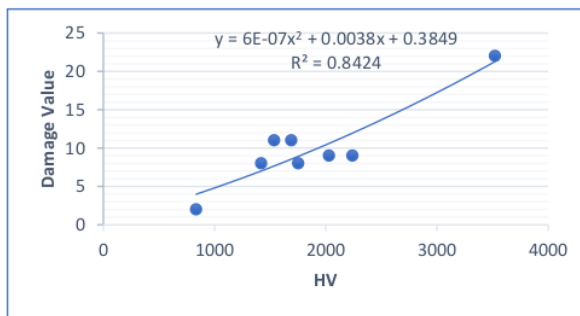


Figure 2 HV and Damage

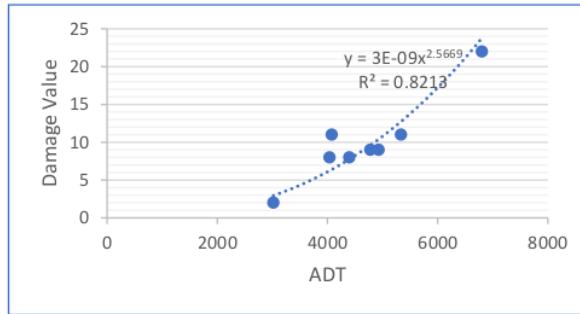


Figure 3 ADT and Damage

In Figure 1 it can be seen that the R2 value is 0.0439, so the r value is 0.2095. This explains that if the correlation between road damage and light vehicles (LV), it means that road damage is not caused by light vehicles. Figure 2 describes the relationship between road damage and heavy vehicles, which has a very strong correlation, with a correlation value (r) of 0.9178. It is clear if the road damage is caused by heavy vehicles (HV). Furthermore, Figure 3 depicts the relationship between the overall average daily

traffic (ADT) and damage, which also shows a very strong correlation with an r value of 0.939.

When viewed based on the P-value, to find out which is more damaging to the road between the volume of light vehicles and heavy vehicles, it can be seen that the P-value of heavy vehicles is <0.05, this explains that the volume of heavy vehicles does affect road damage, as can be seen in Table 8.

Table 8 Multiple Regression Analysis

	Coefficients	Standard Error	t Stat	P-value
Intercept	-8,543495	4,204905	-2,03179	0,09789
LV	0,0027192	0,00158227	1,71855	0,14634
	0,0066422	0,00102636	6,47154	0,00131
Multiple R	0,914354			
R Square	0,836042			
Adjusted R Square	0,808716			
Standard Error	4,204905			
Observations	7			

**Relationship Road Damage and Load (ESA)**

Value of road damage and load on the observed road segments, as shown in Table 9.

Table 9 Damage Value and Load

No.	Damage Value	ESA
1	8	16385
2	11	19548
3	9	27680
4	2	9286
5	11	19439
6	22	42402
7	9	27346
8	8	20054

The results of the analysis show that loads have a very strong influence on road damage, with a correlation value (r) of 0.9037. From Figure 4, as shown below, a correlation value

(r) of 0.9073 is produced, this explains that the relationship between the influence of the load of passing vehicles on road damage is very strong.



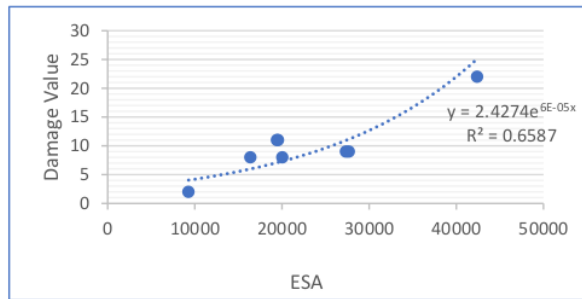


Figure 4 Load and Damage Value

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**5. CONCLUSION**

From the results of the analysis it can be concluded that road damage is affected by the volume of heavy vehicles. The analysis yields the equation  $y = 6E-07x^2 + 0.0038x + 0.3849$  with a very strong correlation with the r value of 0.9178. Heavy vehicles significantly damage the road compared to

light vehicles, it can be seen from the Pvalue which is less than 0.05.

Analysis of the standard load (ESA), road damage has a very strong correlation with an r value of 0.9073 with the equation  $y = 2.4274.e6E-05X$ .

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