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Damage Analysis of Structural Flexible Pavement in Towua Road Link in Palu City

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ABSTRACT: Based on the results of the preliminary survey conducted along Towua roads there are some and the stock as exfoliation layers the surface of , the release of grains , split open and crack. So as to cause a lack of security and comfort for road users. The purpose of the study to identify a kind of , the level of , and the percentage of road damage priority value on roads towua and the factors causing the damage occurs and apply the method or the treatment of defects that occurred on Towua roads.
The methods used in analyze the research by using the Bina Marga methods and testing in the laboratory to examine 3 bricket sample taken at 3 location points, in their respective STA : KM 00 + 300, STA : KM 00 + 500, and STA : KM 00 + 800. Based on the result of damage analysis on Towua Road, the percentage of total damage was 42,349% or 7020,617 M² from the total area of Towua Road with priority value (UP) = 1 where the condition of the road was severely damaged, so there was a need to increase the road by being re-coated (layer added overlay). While the test results in the laboratory obtained asphalt content for point 1 (6.5%), point 2 (8.23%) and point 3 (6.13%), as well as the results of the examination of gradation on the surface layer does not meet the specifications used. At some location points, for example in STA: KM 00 + 300 - 00 + 600 has a very poor drainage system with a traffic load that exceeds Towua Road capacity of 22,179.8 SMP / Day / 2 directions, so it is not possible to cause damage to the Towua Road section
Keywords : Road damages, Laboratory Test, asphalt content.

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I. INTRODUCTION

Transportation facilities and infrastructure play a very important role in distributing goods and services including human mobility. One of the most important transportation infrastructures developed is roads, both roads and railroads. The existence and good quality of roads will greatly support efforts to accelerate development and attract investors from outside to invest in Indonesia. [3]

The ability of a highway is determined by the type and quality of the planned construction, as well as the carrying capacity of the subgrade as a support for construction, so it is deemed necessary to avoid problems related to road damage as long as it is within the service period. [5]

Towua Road is one of the roads in the Palu city, which is located in the District of South Tatura, with a road length of 1842 m and a road width of 9-11 m with a row of offices, trading sites, refueling places, health care workers (hospitals and pharmacies) which is quite dense along the road as a puller of movement.

The condition of the current JalanTowua section is quite worrying, this can all be seen from the shape of the damaged road surface and having a poor drainage system, for example in STA: KM 00 + 300 - 00 + 600. When rain falls there will even be a puddle of water residents 'houses on the edge of the road, because the position of the road with the shoulder of the road is higher compared to the residents' yard. With these conditions, rehabilitation of the JalanTowua section is needed to improve the quality of the road. Based on the results of the initial survey conducted along the JalanTowua segment there were several types of damage such as peeling of the surface layer, release of grains, splitting and cracking. So that it causes a lack of comfort and security for road users when passing through the road, both drivers and passengers.

II. GENERAL DESCRIPTION OF RESEARCH LOCATIONS

2.1 Research Sites

[1] Palu City is the capital of Central Sulawesi Province which is the center of government, economic and trade activities. Palu City is located in the mainland area of the Palu valley and Palu Bay which is astronomically located between 0 ° 36 "- 0 ° 56" LS and 119° 45 "- 121 ° 01" BT right below the equator with a height of 0-700 meters from sea level.

Towua Street is one of the roads located in South TaturaSubdistrict, Palu City which is the location of research in completing the Final Project at the Faculty of Engineering, University of Tadulako. JalanTowua, Palu City, where the handling is carried out by the Regional Highways Office of Central Sulawesi Province.

This road starts from the intersection of Jalan I GustiNgurah Rai - JalanBasukiRahmat - JalanEmySaelan, and ends at the intersection of JalanKaranjaLembah - Jalan Malaya - Jalan Guru Tua with a total length of 1842 meters of road with a width of 9-11 meters [11].

2.2. Demographic Conditions

Based on the results of the registration of the population of Palu City in 2016, it was noted that the population of Palu City reached 374,020 inhabitants. The research location is in South PaluDistrict which has an area of ± 27.38 km2. Based on 2016 Statistics, South Palu District consists of 5 urban villages which are entirely accessible by four-wheeled vehicles and have a population of 69,492 people, with a population density of 2,538 people/km2. [1]. Communities domiciled in the South PaluSubdistrict region consist of various tribes and languages. In terms of profession, the majority of the population living in the South PaluSubdistrict works as traders and others as private employees, employers, laborers and others.

2.3 Segment Status of JalanTowua

Based on the 2011 Central Sulawesi Province Road Network Map and data on the determination of road sections according to their status as provincial roads. It is known that the JalanTowua segment is a provincial road with Primary Collector road functions, as also stipulated under PP No. 34 of 2006 concerning roads and stated that provincial roads connecting between provincial capitals and district capitals are classified as Primary Collector roads (Article 27 letter (a) and (b)). JalanTowua Section, Kec. South Palu is one of the roads that connects the capital of Central Sulawesi Province with Sigi Regency, so the function of the road is Primary Collector.[10]

Figure 2.1. Sta: 0 + 50 (Bleeding)

Figure 2.2. Sta: 0 + 300 (Alligator Cracking)

Figure 2.3. Sta: 0 + 500 (Exfoliation of the Surface Layer)

III. LITERATURE REVIEW

3.1.General Overview

Highway pavement is formed from various layers, where each layer consists of material that is located and has a thickness that is different according to the road. Beside the road pavement layer is planned to be able to hold/receive vehicle loads with the support power limits, it is also intended to be able to spread the wheel load. The load that works on pavement construction, namely the traffic that crosses the road, influences the effect on theroad surface of the road with the emergence of loads due to the wheels of the vehicle. [2]

Through the wheel contact area, the vehicle load is delegated to the road hardness, then the load is received by the surface layer and the subsequent layers are spread out. Until finally the subgrade carries a small burden of carrying capacity of the subgrade. Traffic loads that work on pavement construction can be divided into: [4]

1. The vehicle load is a vertical style
2. The vehicle brake style is a horizontal force
3. Blow the wheel of the vehicle in the form of vibrations

3.2 Pavement Structure of Bending Road

Road Pavement consists of four types of material layers, each layer consists of different materials and pavement thickness. The arrangement of the flexible pavement layer consists of the surface layer (surface), the upper foundation layer (base), the bottom foundation layer (subbase) and subgrade (subgrade). [12]

Figure 3.1. Pavement Construction Layer

The surface layer is the topmost layer of pavement construction. This layer functions as follows: [12]

a. Hold traffic loads, such as:

1) Vertical force (vehicle load / load)
2) Horizontal force (shear / brake force)
3) Vibration (due to repitition of vehicle wheel loads)

b. Waterproof coating

So that raindrops that fall on it do not seep under the layer so as not to weaken it.

c. Wearing course

Layers that immediately receive friction due to vehicle brakes easily become worn out.

d. The layer that spreads the load to the bottom layer, so that it can be carried by another layer that has a poorer /weaker carrying capacity.

The upper foundation layer is located between the surface layer (surface) with the bottom foundation layer (subbase), this layer functions as:

a. The foundation part that holds the latitude force of the wheel load and spreads the load downward.
b. Infiltration layer for bottom foundation layers.
c. Bearing against surface layer.

The material used for this layer includes broken stone, gravel, sand or a mixture of these materials with lime asphalt and so on. The bottom foundation layer is located between the upper foundation layer (base) with the subgrade layer, this layer functions as: [5]

a. Part of pavement construction to spread the wheel load to the ground. This layer must be strong enough.
b. Efficient use of materials. Bottom foundation material is relatively inexpensive compared to the pavement layer above it.
c. Reducing the thickness of the upper layer which is more expensive.
d. Infiltration layer, so that ground water is not collected in the foundation layer.
e. As the first layer, so that the work runs smoothly. This is due to the force of the field conditions which must immediately cover the base ground from the influence of the weather or the weak carrying capacity of the ground to hold the tool wheel large / heavy.
f. Layer to prevent fine particles from the subgrade rising to the upper foundation layer. For that the bottom foundation layer must meet the filter requirements.

The basic soil is where laying the pavement layer. The strength of road pavement construction is very dependent on the carrying capacity of the basic soil. Baseline also determines the expensive or not construction on the road, because the strength of the subgrade determines the thin thickness of the pavement layer. [12]

3.3. Causes of Flexural Pavement Damage

Damage to flexible pavement construction can be caused by: [10]

1. Traffic, which can be an increase in load, and load reps.
2. Water, which can be derived from rain water, poor road drainage system and rising water due to capillary.
3. Pavement construction material. In this case it can be caused by the nature of the material itself or it can also be caused by an improper material processing system.
4. Climate, Indonesia has a tropical climate, where air temperature and rainfall are generally high, which can be one of the causes of road damage.
5. Unstable subgrade conditions. Possibly caused by a poor implementation system, or it can also be caused by the nature of the basic soil which is not good enough.
6. The process of compacting the top layer of subgrade is not good.

3.4. Type of Flexural Pavement Damage

According to road maintenance manual No. 03 / MN / BB1983 issued by the Directorate General of Highways. Road damage can be distinguished based on the types of damage that will be described one by one in writing as follows: [6]

a. Cracking
b. Distortion (distortion)
c. Disintegration
d. Wear (polished aggegate)
e. Obesity (bleeding / flushing)
f. Decrease in former utility planting

IV. RESEARCH METHOD

4.1 Steps and Research Flow

The research method is a series of studies that refer to the title of this final project research, then the data needed for the purpose of research consists of two parts, namely primary data secondary data. Primary data is obtained from direct observations in the field in the form of initial survey location research and a series of studies related to material physical data carried out in the laboratory. For secondary data obtained from relevant agencies, such as data on the geological condition of the district of Sigi from the Central Statistics Agency of Central Sulawesi Province and data on road hierarchy obtained from the Office of Highways of Central Sulawesi Province.

After setting the purpose of writing, the authors arrange rare - planned activities that will be carried out as guidelines for implementation to achieve the objectives. A series of activities as outlined in the flow chart or flow chart also illustrates the stages of the research as well as an evaluation material for the research activities that will be carried out by the activity plan.

4.2. Initial Survey

This study aims to identify the types of damage to the road and observe environmental conditions both vehicle traffic and drainage conditions as well as document the survey results, also aims to observe and determine the exact sampling location where after we have conducted a survey along the Touwa District of South Palu , then a number of sampling points were established in areas where the damage was most critical for inspection in the laboratory.The samples taken were 3 (three) samples from three points whose damage was considered the most severe with the same depth.

4.3. **Sampling**

Primary data is obtained from identification directly in the field (Field Survey) and a series of studies related to physical data material carried out in the laboratory. Secondary data was obtained from relevant agencies such as the Central Statistics Agency, the Highways Agency of Central Sulawesi Province, and the Meteorology, Climatology and Geophysics Agency (BMKG). The data includes, general description of roads, environmental data, map of the location of the research location.

4.4 Primary Data

After the initial survey, next step that should be carried out is to find out and to determine some sampling points in the area with the most critical damage. Samples were taken on the Touwa sub-district of South Palu as many as 3 (three) samples from 3 points with the most severe damage with the same depth, namely point 1 Km 0 + 300, point 2 Km 0 + 500, point 3 Km 0 + 800. Tata the sampling method is described as follows:

A. Sampling

In taking samples for testing purposes must be done carefully so that it does not affect the physical properties of the sample. For sampling in locations it is necessary to pay attention to the following:

- Samples taken must be intact as before they are taken, so that they represent the material to be used.
- Samples taken by Core Drill are carried out in several different locations.
- The number of samples taken were 3 samples used in the study.

The sampling procedure is described as follows:

1. Equipment

The equipment used is:

a) Drill machine that has a power of 8 HP
b) Drill bits equipped with diamond bits 6 "in diameter

c) Drill coolant installation
d) Crowbar, shovel and hammer
e) Compactor Equipment (Compactor)
f) Warning boards / signs that indicate the existence of research activities

2. Working Steps for Surface Layer Sampling

a) Install warning boards at the sampling location
b) Adjusting the engine position to perpendicular to the road surface to be drilled, lowering the locking leg until the engine position is stable, installing the cooling installation and installing the drill bit (bit)
c) Running the engine at medium speed and lowering the drill bit on a land-based basis, the engine speed will automatically increase if the bit load increases. Drilling is carried out until the foundation layer.
d) Increase the drill bit after the penetration layer is cut off.
e) Measuring the thickness of the surface layer.

3. Work Steps for Taking Foundation and Subgrade Samples

a) Dig a hole measuring 40 x 40 cm using a crowbar.
b) Lifting the excavation results of the foundation with a shovel into the plastic bag provided
c) After excavation of the elevated foundation layer, the excavation is carried out on the subgrade sample at the same point when taking the base layer sampling.
d) Next enter the excavation results of the subgrade into a plastic bag that has been prepared that is separate from the foundation layer.

4. Closing the Sampling Hole

The existing hole is immediately closed again with similar material to the extent that it was before sampling. The procedure performed is:

a)Inserting a continuous gradual aggregate mixture prepared into the hole until it reaches the surface elevation of the pavement foundation.
b) Conduct compaction process with compactor equipment which has been prepared as many as 200 collisions to really solid.
c) Cover the surface of the foundation layer with asphalt that has been heated with a mixture of kerosene.
d) Closing the remaining holes with a continuous graded asphalt and aggregate mixture with a temperature of 120 ‘C that has been prepared in advance and compacting them, the number of compaction collisions is approximately 150 collisions.

5. Sampling Handling

Before the sample is stored in the space provided, the thickness of each layer of pavement is measured first. then the sample is put into a plastic bag and labeled, each box is tightly closed so that it is not contaminated with other materials.

6. Amount of Sampling

Sampling is adjusted to the amount that will be used for laboratory testing, while the samples taken as laboratory tests are:

a) Surface layer, for examination of extraction and sieving
b) Aggregate foundation layer, For screening analysis, Atterbeg boundaries, specific gravity and water absorption
c) Subgrade, for inspection of filter analysis, Atterbeg boundaries, specific gravity and water absorption, compaction and CBR.

B. Average Daily Traffic Observation

I n this traffic observation the author uses a handycam or camera to help record traffic activities for 4 hours each in the morning, afternoon and night. In this observation, researchers will need a surveyor of approximately 4 people to observe traffic with a handycam or camera which will be used at the time of observation.

C. Drainage Conditions

On the Towua road at Km 0 + 000 to Km 1 + 842 is a flat area with the rightand left sides are community settlements, offices, health services, and others. The condition of drainage along JalanTowua is an open channel, like a rectangular trench on which is covered by a mixture of concrete. But at some point there is no drainage channel on the left or right side of the road, causing water inundation in the event of rain and being one of the main factors in damage to this Towua road.

4.5 Secondary Data

Research on the damage analysis of flexible pavement on the JalanTowua section of Palu City requires secondary data from the relevant agencies, the Central Bureau of Statistics, the Office of Highways of Central Sulawesi Province, and the bodies of meteorology, climatology and Geophysics. Secondary data needed are:

1. General description of the road

Explain the status of roads that are directly related to the surrounding area (described in Chapter II page 5, regulated based on PP No. 34 of 2006 concerning roads based on data from the Bina Marga Office of Central Sulawesi Province).

2. Environmental data

Describing geographical location, demography, topography, rainfall, and climate (described in Chapter II pages 2 and 3, based on data from the Palu City Central Bureau of Statistics and the BMKG of Palu City).

3. Map of the location of the road

Describes the JalanTowua segment in this study (using googlemaps.com).

4.6 Sample Check and Data Processing

The experiments and examinations carried out in analyzing the damage to the road that occurred as follows:

1. Examination of asphalt (Asphalt Extraction)

The purpose of this test is to determine the asphalt content in the mixture on the pavement layer, the test object taken from the pavement, is examined asphalt extraction. Calculate the percentage of the weight of asphalt in the mixture and the grain size arrangement with the relationship graph% escaping the sieve size.

2. Examination of Aggregates and Subgrade

a) Filter analysis

This check is intended to determine the distribution of granules (Gradations) aggregate using a sieve. The gradation or distribution of particles based on aggregate size is important in determining the stability of the pavement. Aggregation of the aggregate affects the size of the cavity between the grains which will determine stability and ease in the implementation process. The aggregate gradation was obtained from the results of sieving using a set of filters where the coarse sieves were placed at the top and the smallest at the bottom. A set of filters starts from PAN and ends with a closing. The analysis carried out in this study using dry analysis according to AASHTO T88-90.

b) CBR Laboratory

This examination is intended to determine the CBR (California Bearing Ratio) aggregate foundation and subgrade which is compacted in a laboratory at a certain moisture content. CBR is a comparison between the penetration load of a standard material with the same depth and speed.

The test data is plotted on the CBR file with abscis a penetration value and ordinate is a given burden. The load is obtained from the load dial reading multiplication with the proving ring calibration. Loads that conform to the penetration of 0.1 "and 0.2" compared to standard loads, scattered values are CBR values and are rounded up as follows:

1. For CBR values <30% rounded to 1%

2.For a value of 30% <CBR <100% rounded up to 5%. This inspection is carried out on the aggregate and subgrade foundation layers.

c) Atterbeg Limits

1. Liquid limit

The purpose of this examination is to determine the moisture content of a soil at a liquid boundary state, the liquid limit is the boundary water content where a soil changes from a liquid to a plastic state.The results obtained in the form of the number of blows and the water content in question are then depicted in graphical form. The number as a horizontal axis with a logarithmic scale, while the amount of water as an upright axis with an ordinary scale.Making a straight line through that point if it turns out that the points obtained are not in a straight line, then a straight line is made through the center of the point.

2. Plastic Limit

This check is intended to determine the moisture content of a soil in a plastic boundary state. Plastic limit is the minimum water content where a soil is still in a plastic state. This inspection is carried out on the aggregate and subgrade foundation layers.

d)Specific Gravity and Aggregate Absorption

1. Rough Aggregate Species and Absorption

This check is intended to determine specific gravity (Bulk), Saturated Surface Dry = SSD, apparent density and absorption of coarse aggregates. Measurement of aggregate density is needed for planning aggregate mixtures with asphalt, this mixture is based on a weight ratio because it is more accurate than the volume ratio and also to determine the many aggregate pores. Small density will have a large volume so that with the same weight will require more asphalt. A large pore aggregate will require more asphalt, because a lot of asphalt is absorbed which will cause the bitumen to thin.

2.Specific Gravity and Absorption of Fine Aggregates

The measurement of aggregate density is required for agragat mixed planning with asphalt, this mixture is based on the weight ratio because it is more accurate than the volume ratio and also to determine the many aggregate pores. Small density will have a large volume so that the same weight will require a lot of asphalt.

e) Compaction / Compaction Testing

This test is carried out to obtain meticulous data from compaction results, where the purpose of this compaction is to obtain optimum water content values and maximum dry density levels.

f) Testing of soil specific gravity.

This test is intended to determine the specific gravity of the soil (Specific Grafity = Gs), which is the ratio between soil volume and water volume weight at 29°C. The specific gravity of the soil or the specific weight of the soil is temperature 29°C.

V. RESULTS AND DISCUSSION

At this stage an analysis is carried out with discussion based on the results of the laboratory examination only on the surface layer and discussion of the results of direct field observations, where in some parts of the area the shoulder surface of the road is high so that it cannot drain the side of the road and there is no permanent drainage system so that the water crosses the asphalt surface.The Towua Road segment consists of a portion of flat land contours with the right side is a cliff edge so that rainwater runoff directly crosses the road surface. If the water runoff is not immediately wasted it will enter into the pores of the pavement layer. Water will expand and especially on the asphalt layer will result in a lack of adhesion between aggregates and asphalt so that it easily cracks and peels the grain and exfoliates the surface layer.

5.1.Results of Inspection of Road Towua Material

5.1.1.Surface Layer

-Extraction Check

In the initial survey in the field several types of damage that occurred at several points were considered to be the most severe and most common. For cracking of crocodile skin, sampling was carried out on KM. 0 ± 300, surface lapse peeling damage on KM. 0 ± 500, and damage to the release of grain in KM. 0 ± 800.Sampling of asphalt for each damage was taken using a core drill, followed by an extraction experiment to determine the asphalt content in the mixture on the pavement layer.

Table 5.1 Results of Asphalt Level Test

Sample Test	Section (Km)	Bitumen Content of The Mixture (%)	Bitumen Content of The Aggregate (5)
Point-1	0 + 300	6,50	7,00
Point-2	0 + 500	8,23	9,00
Point-3	0 + 800	6,13	6,53

Of the three examinations above obtained asphalt levels did not meet the specifications. The specifications for asphalt levels for the AC-WC surface layer are 4.3 - 5.1%. This shows that the bitumen content in the field does not meet the required asphalt content specifications, where high asphalt content will show that the asphalt mixture with aggregate is not good because it is not in accordance with predetermined proportions to facilitate damage.

- Gradation Test

From the results of the extraction examination above, it is continued by examining the composition of the grain gradations whose results can be seen in table 5.2.

Table 5.2. Surface Layer Gradation at Point 1

Sieve Number	Percent Passing (%)			Surface Layer Specifications
	Left Side Bricked	Centre Side Bricked	Right Side Bricked	
¾”	100	100	100	100
½”	94,905	91,803	94,055	90 - 100
3/8”	88,471	87,651	86,602	77 - 90
#4	77,868	76,734	73,909	53 - 69
#8	59,247	55,996	49,536	33 - 53
#16	46,022	42, 651	35,446	21 - 40
#30	35,174	31,057	26,187	14 - 30

#50	24,493	19,071	18,511	9 - 22
#100	13,732	9,863	10,470	6 - 15
#200	7,274	5,028	5,521	4 - 9
PAN	0,959	0,890	4,073	

Table 5.3. Surface Layer Gradation at Point 2

Sieve Number	Percent Passing (%)			Surface Layer Specifications
	Left Side Bricked	Centre Side Bricked	Right Side Bricked	
¾"	100	100	100	100
½"	97,382	94,931	92,749	90 - 100
3/8"	92,587	88,637	87,076	77 - 90
#4	80,355	75,669	71,126	53 - 69
#8	44,795	42,242	41,905	33 - 53
#16	27,205	23,669	26,949	21 - 40
#30	17,872	14,024	18,148	14 - 30
#50	12,575	8,631	12,877	9 - 22
#100	7,951	3,633	8,155	6 - 15
#200	4,746	-0,394	5,202	4 - 9
PAN	0,648	-3,717	4,517	

Table 5.4. Surface Layer Gradation Point 3

Sieve Number	Percent Passing (%)			Surface Layer Specifications
	Left Side Bricked	Centre Side Bricked	Right Side Bricked	
¾"	100	100	100	100
½"	96,210	93,976	94,406	90 - 100
3/8"	93,457	91,569	89,783	77 - 90
#4	88,502	78,488	84,199	53 - 69
#8	71,166	46,065	68,836	33 - 53
#16	56,644	30,784	53,433	21 - 40
#30	46,511	22,737	44,693	14 - 30
#50	36,448	18,338	35,049	9 - 22
#100	22,620	13,967	21,773	6 - 15
#200	16,276	9,774	16,364	4 - 9
PAN	8,109	3,662	-40,086	

5.2. Analysis of the Causes of Towua Road Damage Based on Laboratory Test Results

5.2.1.Alligator Cracking

Based on the results of the survey and identification of damage to the road that has been processed, the percentage of roads that experienced overall crack damage along JalanTowua was 9,415%. The cracks that occur have a gap of 3-7 mm. The length of the cracks ranges from 4.18 to 76.32 m, with a width of 0.83 m to 1.12 m.

Asphalt content that is not according to the specifications specified, shows that the asphalt and aggregate mixture is not good or the bond strength between asphalt and aggregate is not good. For gradations that are not included in the specifications, it is likely that the required technical properties cannot be met, one of which may occur when mixing material in the AMP (Asphalt Mixing Plan) which is not good and results in easy cracking in the pavement layer of JalanTowua. In addition, crack damage is also caused by the repitition of traffic loads that have exceeded the load capacity limit that can be borne by the surface layer, and due to dynamic loading that is repetitive loading due to fatigue in the material, so that in theend it will reduce the strength of the layer these surfaces.

5.2.2. Exfoliation of the Surface Layer

The hole is shaped like a bowl, into the hole until the previous pavement layer. Hole size varies, with lengths of 1.88 m to 53.27 m while the width is between 1.37 to 2.82 m. Based on the results of the survey and identification of damage to the treated road, the percentage of the road that suffered overall surface peeling damage along JalanTowua, Palu, was 21.304%.

Based on field observations, there are several parts of the road that do not have drainage channels, but when it rains, only a small portion of rainwater which is held above the rest of the road flows to the shoulder of the road until it enters people's homes. Although only a small portion of water held above the road surface does

not rule out the possibility that it will affect the pavement layer. As a result, the pavement which contains water will expand and especially on the asphalt layer will result in a lack of adhesion between aggregates and asphalt so that it is easy to experience overlay damage and if it is not repaired soon the damage will develop into a holerepitition combination of traffic loads.

5.2.3.. Release of Granules

Based on the results of the survey and identification of damage to the road that has been treated, then the percentage of roads that have overall deterioration of grain release along JalanTowua, Kota Palu is 11.63%. The release of grains that occur has a length of damage ranging from 5.42 m to 28.36 m, with a width of 1.97 m to 2.57 m.The location of the damage is inundated in the event of rain and poor drainage systems, so technically the road will experience peeling of the surface layer if stagnant water takes place in a long time, so that the release of grains on the surface layer and can develop into holes as a result combination of traffic loads that do not match the capacity of the road.

VI. CONCLUSIONS AND SUGGESTIONS

6.1. CONCLUSIONS

Based on data obtained from direct surveys at the research location and the results of research in the laboratory as well as analysis of test results, conclusions can be taken as follows:

6.1.1. The Type and Level of Damage

The type and level of damage that occurred in the JalanTowua Kota Palu segment was cracked by crocodile skin and edge cracks with a percentage of damage = 9.415%; surface peeling = 21.304%; release of grain = 11.63%. So that the total number of damaged roads is 42,349% or 7020,617 M² of the total stretch of JalanTowua Kota Palu and priotas (UP) = 1, meaning that the road is functionally in the condition of severe damage.

6.1.2. The Factors that Cause Damage

a). Bitumen Content and Gradation Settings

Based on laboratory test results obtained asphalt levels for examination at point 1 cracked crocodile skin damage (6.5%), examination at point 2 surface peeling damage (8.23%) and examination on item 3 damage to grain release (6.13%) while the specification of bitumen content for the AC-WC surface layer is 4.3 - 5.1%, this indicates that the asphalt content in the field does not meet the specifications of the asphalt content indicated. The aggregate gradation checks on the surface layer of each damage also do not meet the specifications.

b). Drainage Conditions

In several locations, such as STA: KM 00 + 300-00 + 600 does not have a drainage system, so that when it rains the waterwill flow into the shoulder of the road to enter the courtyard houses right on the side of the road.

c).Traffic Flow Conditions

Based on the results of the previous survey, obtained by LHR LHR way of 22179.8 SMP / Day / 2 Directions, while the junior high capacity for primary collector road is 6000-20000. This shows that the traffic load on the JalanTowua segment has exceeded the required capacity.

6.1.3. Proper Handling Needs To Be Done With the Following Stages:

a). For surface peeling damage, repairs are done by dismantling and re-coating (added layer overlay) with materials that comply with the applicable technical specifications.
b). For damage to crocodile skin handling by means of resurfacing the new surface above it includes one-layer asphalt (Burtu), two-layer asphalt (Burda), and thin layer of asphalt (Lataston). Can also be repaired by means of sprinkling hot and compressed aggregates.
c). For damage to the release of grain handling by means of one-layer asphalt (Burtu), two-layer asphalt (Burda), and thin asphalt concrete (Lataston).

6.2.SUGGESTIONS

6.2.1.In carrying out the work to increase the Road Towua section of Palu City in the future, it is expected that the implementing road improvement work must really pay attention to the asphalt content and aggregate gradation in the pavement mixture to be used in order to meet the requirements or specifications of the

stipulated mixture plan and formation road shoulder and drainage that correspond to the height of the pavement surface.

6.2.2.In the future implementation of the work to increase the JalanTowua section of Palu City, it is expected that the implementing parties for road improvement work will conduct material test tests on road transport laboratories so that the type of gradation of the material will be known.

6.2.3.Before paving the road must calibrate the AMP (Asphalt Mixing Plant) tool in order to control the use of asphalt and mixture gradations so that there are no shortages or excesses in carrying out the scales both asphalt and gradation levels.

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