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# ANALYSIS DAMAGE PAVEMENT USING BINAMARGA METHOD ON LAMONGAN-GRESIK ROAD STA 45+200 - 47+200

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## ABSTRACT

Lamongan-Gresik road is one of the main roads that is connected to the capital city of East Java Province, Surabaya. This study was conducted to assess damages on the road and to determine the priority level of handling it by conducting a visual survey, pavement surface damage measurement, and LHR survey for one day on the road section. Bina Marga method was utilized in the analysis comprising six types of road damages that are identified, namely: photole, patches, alligator cracking, rutting, reflection cracking, longitudinal and transverse cracks, depression grade, and polished aggregate. The major type of damages is alligator cracking (41.00%) with an area of 792.76 m2, while the minor type of damages is photole (0.08%) with an area of 1.54 m2 from Gresik to Babat, while the major type of damage is alligator cracking by 53.00% with an area of 801.27 m2, and the minor type of damage is reflection cracking by 0.20% with an area of 3.08 m2 from Babat to Gresik. Based on the type of pavement damages reviewed, namely Asphalt (P2), the types of damages that are repaired using local asphalt are alligator cracks, box cracks, longitudinal and transverse cracks with width < 2 mm, and ravelling. Filling the hole (P5) Damages repaired with this method are box cracks, Aligator cracks with crack width > 2 mm and subsidence, and holes > 50 mm deep. Leveling (P6) Damages that need to be repaired by leveling is settlement/subsidence, holes with a depth of 10-50 cm, groove depth < 30 mm.

Keywords: Road Damages, Road Maintenance, Bina Marga Method

## 1. INTRODUCTION

Roads are an important tool in life, especially in the distribution of goods and services by facilitating inter-sectoral and inter-regional economic development efforts as a facility to assist in the movement of land. This development reflects economic growth supported by adequate road infrastructure to enable development to be carried out safely, efficiently and on time. Heavy and repetitive road conditions can affect the quality of the road surface and make overtaking uncomfortable and dangerous. Road damages are approved by an authorized body and continue to be approved, resulting in many losses. They lead to delayed power distribution times and economic growth. Road damages not only cause damages to spare parts of road users' vehicles, but they also reduce the comfort of road users and cause accidents.

Basically, the planned age of the road surface is tailored to the situation and traffic requirements and is usually planned for 10 to 20 years; so, it is not expected to cause significant damages in the first 5 years. However, in reality, many of the damages that occur are shorter than the planned useful life, which can lead to major problems in the future. Thus, it is important to keeping the quality of the road on schedule at a level suitable for comfortable and safe use. In addition to the passability of various means of transportation, the road surface should be evaluated to determine if the road is in good condition and suitable for use, or if regular maintenance or regular maintenance can be performed.

The form of road maintenance can be determined from the visual evaluation results. Some of the methods the author uses in this study are expected to be suitable for dealing with road damages and the existing drainage system at the study site. Some similar studies conducted in different ways use Bina Marga, PCI, SDI, and IRI, while others use Bina Marga and PCI.Some journals reviewed in this study use Vinamarga method to analyze road damages Lamongan-Gresik Road section is a national highway and one of the routes that support the city of Surabaya. The road that divides Lamongan district is one of the most densely populated roads alongside the North Coast Road north of the Lamongan district. Many factories line the road, making Lamongan-

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Gresik Road a busy highway with high potential for damages.

## 2. RESEARCH METHODOLOGY

This research is conducted by holding visual surveys, measurements of pavement surface damage, and LHR surveys for one day on the road section. After obtaining data from the field, the analysis is carried out using the Bina Marga method.

### Bina Marga Method

In this Bina Marga method, the types of damages that need to be considered when conducting surveys are photole, patches, alligator cracking, rutting, reflection cracking, longitudinal and transverse cracks, depression grade, and polished aggregate. The determination of the value of road conditions is carried out by adding up each number and the value for each state of damages. Evaluation of road damage conditions is very necessary to monitor how much a damage occurs to a road section. The results will be very helpful for the preparation of rehabilitation programs and road handling.

### Data Analysis Procedure

In carrying out calculations and data collection, it is very important to understand the procedures and technical workings so that the managed data can produce a concrete and in-depth analysis. In this data analysis procedure, Bina Marga methods are used.

In analyzing data using Bina Marga method, it is necessary to carry out the following procedures:

1. Calculateing LHR for surveyed roads and assigning road class values based on traffic class based on LHR (SMP/Hour).
2. Calculating the percentage of damages
   $$Aligator\ Crack = \frac{Damages\ in\ Segment\ Area}{Segment\ Area} \times 100\%.$$
   The data from the survey on road conditions in the form of types and size of the damages ares calculated to get the area of each type of damages, added up to obtain a total score for each type of damages. The percentage of damage types is obtained from the division between the types of damages with a segment area of 100 meters multiplied by 100%.
3. Making a table for the survey results and grouping the data according to the types of damages.
4. Calculating parameters for each type of damages and assessing each type of damages based on the number of conditions on the type of damages. Adding up each number for all types of damages and assigning road condition values based on road condition classes.
5. The condition value is the value assigned to the road conditions. This value is obtained from the total score in all segments on the road segment divided by the number of segments

The following equation is used to calculate the priority value of road conditions:

UP (Priority Order)
= **17 – (LHR Class + Road Condition Value)**

With:

1. LHR Class = Traffic Class for maintenance work.
2. Value of road conditions = Value assigned to road conditions.
3. The order of priority is 0 - 3, indicating that heavily damaged roads need to be included in the road improvement program.
4. The order of priority is 4 – 6, indicating that the damaged road is in need of being included in the periodic maintenance program.
5. Priority order > 7, indicating that the lightly damaged road is included in the routine maintenance program

The same steps are carried out for the calculation of all surveyed roads. After all the roads are obtained, it can be seen which roads have the largest and smallest damage values. In Bina Marga method, the condition assessment is intended for the purpose of assessing road handling and maintenance.

### Handling Priority Order Assessment and Repair Method

Handling of road repairs can be done routinely or periodically. Road repairs are carried out routinely and continuously throughout the year and performed immediately after damages occur. Maintenance and repairs are carried out at the stage of minor and local damagesdue to the relatively low repair cost and the relatively easy/light way to repair it.

The guidelines used for handling damages to the road surface layer for existing flexible pavements refer to the standard repair method from the Directorate General of Highways, 2010. The following are the types of damage handling according to the standard repair method (Directorate General of Highways, 2010).

1. P1 Repair Method (Sand Spread), The location of asphalt fatness, especially on bends and inclines. Handling steps include:
   a. Mobilizing equipment, workers and materials to site.
   b. Marking the road to be repaired.
   c. Cleaning the area with an air compressor.

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d. Spreading coarse sand or fine aggregate > 10 mm thick over the damaged surface.
e. Compacting with light compactor (weight 1 – 2 tons) until a flat surface is obtained and has an optimal density of up to 95.
f. Cleaning the work place from the remaining materials and tools.

2. Repair Method P2 (Local Asphalt Laboratories), Damage to the shoulder of the paved road, Alligator cracks < 2 mm wide, Transverse cracks, Diagonal cracks and Longitudinal cracks with crack width < 2 mm, Peeled off. Handling steps include:
   a. Mobilizing equipment, workers, and material to location. Providing a sign of the road that will be repaired.
   b. Cleaning the area with an air compressor.
   c. Spreading coarse sand or fine aggregate with a thickness of 5 mm over the damaged surface until smooth.
   d. Compacting with a pneumatic machine until a flat surface is obtained and has an optimal density of up to 95%.
   e. Cleaning the work area from residual materials and tools.
3. P3 Repair Method (Crack Coating), One-way crack locations with crack width < 3 mm. Handling steps include:
   a. Mobilizing equipment, workers and materials to site.
   b. Providing a sign of the road that will be repaired.
   c. Cleaning the area with an air compressor.
   d. Making mixture of asphalt emulsion and sand gauze using Concrete Mixer with the following composition: 20 litres of sand and 6 litres of Asphalt emulsion.
   e. Spraying tack coat with RC type emulsion asphalt (0.2 lt/m) on the area to be repaired.
   f. Spreading and flattening the mixture of fine aggregate over the damaged surface until smooth.
   g. Performing light density (1 – 2 tons) until a flat surface is obtained and has an optimal density of up to 95%.
   h. Cleaning the work area from residual materials and safety equipment.
4. P4 Repair Method (Charging Crack), One-way crack locations with crack width < 3 mm. Handling steps include:
   a. Mobilizing equipment, workers and materials to site.
   b. Providing a sign of the road that will be repaired.
   c. Cleaning the area with an air compressor. Filling the cracks with tackback asphalt (2 lt/m2) using an asphalt spayer.
   d. Spreading coarse sand or fine aggregate > 10 mm thick over the damaged surface.
   e. Compacting with a baby roller at least 3 passes.
   f. Re-lifting the safety signs and cleaning the location of the remaining material.
   g. Demobilizing.
5. P5 Repair Method (Hole Patching), Holes with depth > 50 mm, Alligator cracks > 3 mm, Corrugated with a depth of > 30 mm, Grooves > 30 mm deep, Subside with depth > 50 mm, Road pavement edge damage. Handling steps include:
   a. Mobilizing equipment, workers and materials to site.
   b. Marking the road to be repaired.
   c. Excavating the material until it reaches the material below it (usually the road works with the depth of 150 – 200 mm must be repaired).
   d. Cleaning the repaired area with an air compressor.
   e. Checking the optimum moisture content of existing road work materials. Adding water if dry to optimum conditions. Digging out the material if it is wet and allowing it to dry.
   f. Compacting the bottom of the excavation using a hand compactor.
   g. Filling the excavation with aggregate foundation material, namely class A or class B (maximum thickness 15 cm), then compacting the aggregate in a state of optimum water content to maximum density.
   h. Spraying an absorbent layer (binding) prime coat RS type at a rate of 0.5 lt/m2. For Cut Back type MC-30 or 0.8 lt/m2 for emulation asphalt.
   i. Mixing aggregate for cold mix in Concrete Mixer with ratio of coarse and fine aggregate 1.5: 1. Maximum capacity of asphalt mixer is approx. 0.1 m3 aggregate 0.1 m3 For cold mix, adding all before bitumen. Adding asphalt and stirring for 4 minutes, preparing enough cold asphalt mixture for the whole job.
   j. Spreading and compacting the cold asphalt mixture with a maximum thickness of 40

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mm until a flat surface is obtained using a levelling tool.

k. Compacting with Baby Roller minimum 5 passes, adding material if needed.
l. Cleaning the field and checking equipment with existing surfaces.

6. P6 Repair Method (Alignment), Holes with a depth of < 50 mm, Corrugated with a depth of < 30 mm, Location of the drop with a depth of < 50 mm, Grooves with a depth of < 30 mm, Jembul with a depth of < 50 mm, Road pavement edge damage. Handling steps include:
   a. Mobilizing equipment, workers and materials to site.
   b. Marking the road to be repaired.
   c. Cleaning the repaired area with an air compressor.
   d. Spraying a tack coat of the RS type on the damaged area of 0.5 lt/m2 for emulsified asphalt or 0.2 lt/m2 for cut back with asphalt ketlle/perforated cans.
   e. Stirring aggregate for cold mix with ratio.
   f. 1.5 coarse aggregate: 1.0 fine aggregate. The maximum capacity of the mixer is approx. 0.1 m3. For the cold mixture, 0.1 m3 of aggregate is added before the asphalt.
   g. Adding asphalt material and stirring for 4 minutes.
   h. Preparing cold mix asphalt class A, class C, class E, or asphalt concrete mix sufficiently until the job is completed.
   i. Spreading the cold asphalt mixture on the marked surface, to a thickness above the minimum surface of 10 mm.
   j. Compacting with Baby Roller (minimum 5 passes) until optimum density is obtained.
7. Levelling and Regrading Methods
   a. Determining the pavement area to be treated.
   b. Scratching the specified section of the road with a motor grader or manually to a depth of 3-4 cm.
   c. If needed, adding enough fine aggregate and mix with the scratching material until evenly distributed.
   d. Grading and shaping the cross-slope as required with a motor grader or manually. adding enough water if the material is too dry.
   e. Compacting with a compactor until a density is obtained.
8. Gravel Adding Method (Regravelling)
   a. Determining the pavement area to be treated.
   b. Scratching the specified road section with a motor grader or manually to a depth of 3-4 cm.
   c. Spread the fine agreggate on the scratching area. The thickness of the gravel before compaction is approximately 1.20 × the planned solid thickness.
   d. Levelling and shaping the cross-slope as required with a motor grater or manually. Adding enough water if the material is too dry, Compacting with a compactor until an optimum and uniform density is obtained

The conclusion explains the final result of the problem formulation in the application of the Bina Marga method in analyzing the damages that occurr on Lamongan-Gresik Road STA 45+200-47+200. It is definitely and hopefully useful to improve the ability to analyze and add insight for the author so that it can be a provision for work in the future. In addition, it provides information to the public about the level of damage in Lamongan Regency, especially on Lamongan-Gresik Road STA 45+200-47+200. It can also become a reference for similar research conducted in the future and as a reference for lecturer activities in the Department of Civil Engineering.

## 3. RESULTS AND DISCUSSION

This Analysis calculation of road class with LHR is by way of Ekr vehicle type multiplied by the volume of traffic per hour then get the volume of SMP / Hour traffic.The road class value on the Lamongan-Gresik Road obtained a traffic volume of 4037 vehicles with an LHR value of 2148.20 SMP/ hour is included in the road class with a value of 5 which can be seen in the Traffic Class Determination Table based on LHR (SMP / Hour)

Table. 1 Recapitulation of Classification of LHR Values

| LHR (SMP/Hour) | Class Road Value |
|---|---|
| <20 | 0 |
| 20 – 50 | 1 |
| 50 – 200 | 2 |
| 200 – 500 | 3 |
| 500 – 2000 | 4 |
| 2000 – 5000 | 5 |
| 5000 – 20000 | 6 |
| 20000 – 50000 | 7 |

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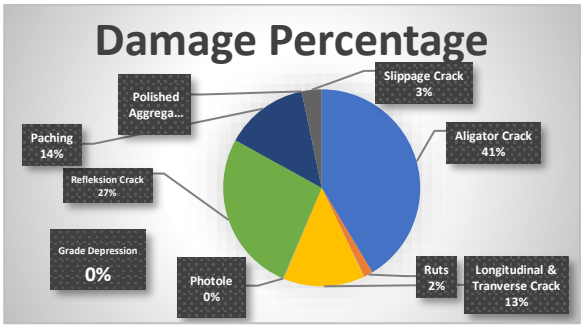
| | |
|---|---|
| >50000 | 8 |

Based on the LHR value of 2148.20 which is on the Lamongan–Gresik STA 45 +200 – 47 +200 segment which means that it has a traffic class number of 5.

The data of the road condition survey results in the form of damage types and measures are calculated to get the area of each type of damage, from the type of damage is added up so that the total score for each type of damage is obtained. The percentage of damage types obtained from the quotient between damage types with segment area per 100 meters multiplied by 100%. The Lamongan-Gresik Road segment that has been analyzed for road conditions is 2 KM long and the width of one-way Rutting is 7 m, divided into 40 segments, 20 segments in the direction to Gresik and 20 segments in the direction to Babat, Lamongan namely the STA segment 45 + 200 – 45 + 300, STA segments 45 + 300 – 45+400, segment 45+400 – 45+500 and so on. Area 100 meters = 100 x 7 = 700 m².

Table 2. Total Area of Damages on Lamongan-Gresik Road STA 45+200 – 47+200 Directions to Babat

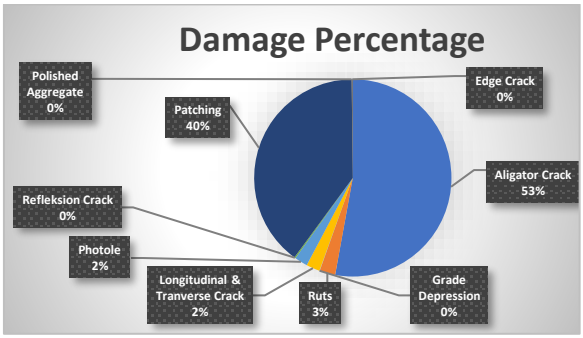
| Types of Damages | Total Area Damage by Type | Point Percentage (%) |
|---|---|---|
| Alligator Crack | 792.76 | 41.40 |
| Rutting | 27.92 | 1.46 |
| Depression | 1.75 | 0.09 |
| Longitudinal & Transverse Crack | 256.62 | 13.40 |
| Photole | 1.52 | 0.08 |
| Join Reflection Crack | 509.20 | 26.59 |
| Patching | 262.51 | 13.71 |
| Ravelling | 0.17 | 0.01 |
| Total | 1914.93 | 100 |




Picture 1. Damage Percentages of Lamongan-Gresik Road STA 45+200 – 47+200 Directions to Babat

Table 3. Total Area of Damages on Lamongan-Gresik Road STA 45+200 – 47+200 Directions to Gresik

| Types of Damages | Total Area Damage by Type | Point Percentage (%) |
|---|---|---|
| Alligator Crack | 801.27 | 52.87 |
| Rutting | 39.03 | 2.58 |
| Depression | 0.85 | 0.06 |
| Longitudinal & Transverse Crack | 33.85 | 2.23 |
| Photole | 32.49 | 2.14 |
| Reflection Crack | 3.08 | 0.20 |
| Patching | 602.10 | 39.73 |
| Ravelling | 0.09 | 0.01 |
| Total | 1515.54 | 100 |




Picture 2 Damage Percentages of Lamongan-Gresik Road STA 45+200 – 47+200 Directions to Gresik

Calculation of the damage figure for damage to groups, holes and patches, is based on the types of damages alone. As for the type of crack damage, the damage figure is considered from the type of crack, the width of the crack, and the extent of the damage, where the value of the crack group used is the largest number of the three components above. For grooves, the damage figure is based on the magnitude of the depth of the groove that occurs, while for Depression the damage figure is based on the length of the Depression every 100 meters.

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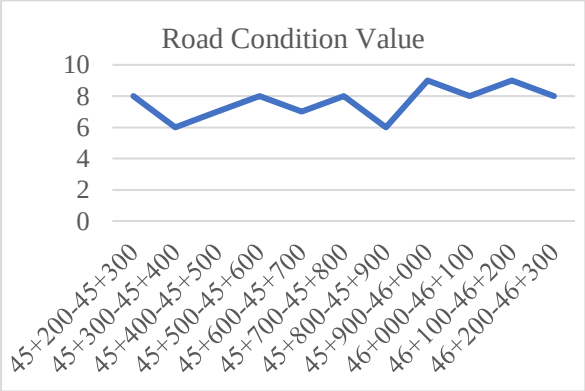
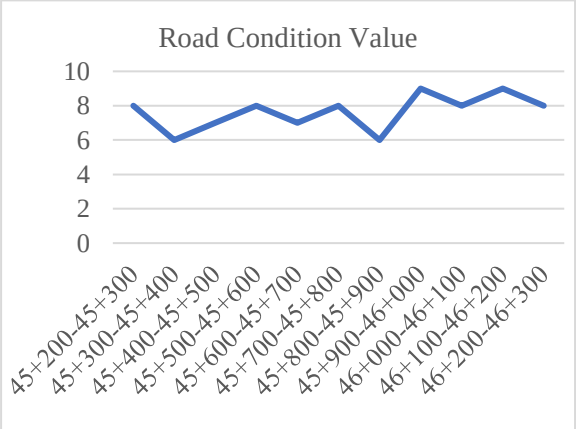



Picture 3 Road Condition Value of Lamongan-Gresik Road Damages

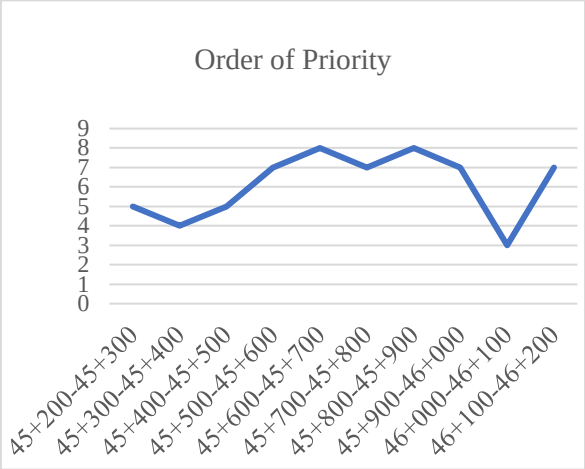



Picture 4 Road Condition Value of Lamongan-Gresik Road Damages

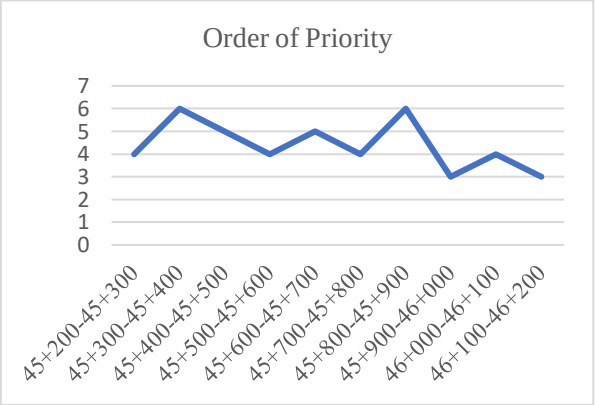
To get the results, you can use the following formula: UP (Order Priority) = 17 – ( Class LHR + Road Condition Value). with:

1. LHR Class = Traffic Class for maintenance work.
2. Road condition value = Value given to road conditions
3. Priority order 0 - 3, indicating that the road needs to be included in the road improvement program.
4. Priority order 4 – 6, indicating that the road needs to be included in the regular maintenance program.

Priority order > 7, indicating that the road is included in the routine maintenance program




Picture 5 Order of Priority STA 45+200 - 46+200 Directions to Gresik




Picture 6. Order of Priority STA 45+200 - 46+200 Directions to Babat

From the results of the final recapitulation on each segment of Lamongan-Gresik STA road 45+200 – 47+000 Direction to Babat above, the smallest priority order is at STA 45 +400 - 45+500, 45+600 - 45+ 700, 46+000 - 46+100, 46+900 - 47+000 and 47+100 - 47+200 with a value of 3 entering the category of severely damaged and young actions taken, namely the road improvement program. Meanwhile, the largest is at STA 45 +200 - 45 +300, 46 +400 - 46 +500, 46 +400 - 46+500, 46+500 - 46+600, 46+600 - 46+700, 46+700 - 46+800 , 46+800 - 46+900 and 47+000 - 47+100 with a value of 8 falling into the category of light damages and the actions taken are maintenance in a manner routine.

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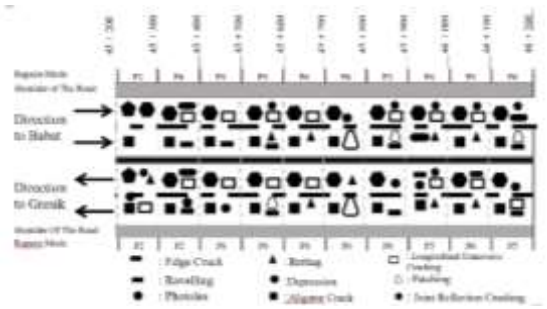
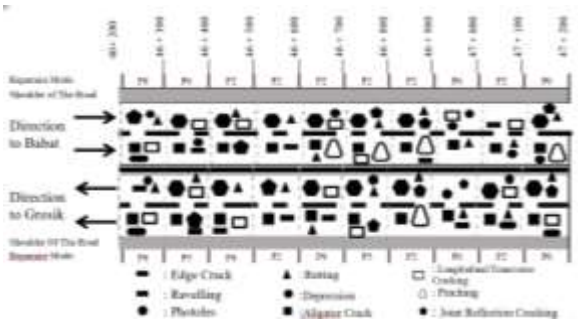
From research on e Lamongan-Gresik highway, Lamongan STA 45+200 – 47+200 along 2 STA can be described as the type of damage per segment (Strip Map) to facilitate the repair process or handling damages to a road to facilitate the repair process or handling damages to a road.




Picture 7. Strip Map Lamongan-Gresik Road STA 45+200 - 46+200

From the strip map image of Lamongan-Gresik highway, Lamongan STA 45+200 – 47+200 the least type of damage is at STA 45+200 – 47+300 Direction to Babat in which the amount of damage is 3, and the most types of damage are in STA 45+500 – 45+600, 45+800 – 45+900, 46+100 – 46+200, Direction to Babat with an amount of damage of 6. Meanwhile, in direction to Gresik there are 3 segments whose types of damages are the least, namely at 45 +400 – 45 + 500, 45 + 600 – 45 + 700, 45 + 800 – 45 + 900, and there are 2 segments with the largest amount of damage at 45+200 – 45+300, 45+300 – 45+400




Picture 8. Strip Map Lamongan-Gresik Road STA 45+200 - 46+200

From the image of the Lamongan-Gresik highway strip map, Lamongan STA 45+200 – 47+200 the least type of damage is at STA 46 + 500 – 46 + 600 which is the segment whose type of damage is the least, namely 4 types of damages. The segments with the largest amount of damage are at 46 + 200 – 46 + 3 00, 46+300 – 46+400, 46+700 – 46+800, 47+000 – 47+100, 47+100 – 47+200 with 6 types of damages at STA 46+500 – 46+600. In Direction to Babat, the amount of damage is 4, and the most types of damages are on STA 46+200 – 46+300, 46+600 – 46+700, 46+700 – 46+800, 46+800 – 46+900. In Direction to Tripe, the amount of damage is 6.,

## 4. CONCLUSION

From the results of the analysis of road damages on Lamongan-Gresik Road, the major type of damages is alligator cracking (41.00%) with an area of 792.76 m2, while the minor type of damages is photole (0.08%) with an area of 1.54 m2 from Gresik to Babat. Meanwhile, from Babat to Gresik**,** the major type of damages is alligator cracking (53.00%) with an area of 801.27 m2, and the minor type of damages is reflection cracking (0.20%) with an area of 3.08 m2.

Based on the type of pavement damage being reviewed, the repair method used is based on the 1990 Routine Road Maintenance Practical Instructions, namely Asphalt (P2). The types of damages that are repaired using local asphalt are alligator cracks, box cracks, longitudinal and transverse cracks with width < 2 mm, and ravelling. Filling the hole (P5) Damages repaired with this method are box cracks, alligator cracks with crack width > 2 mm and subsidence, and holes > 50 mm deep. Leveling (P6) Damages that need to be repaired by leveling is settlement/subsidence, holes with a depth of 10-50 cm, groove depth < 30 mm

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