

# Road Maintenance and Rehabilitation Program Using Functional and Structural Assessment

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**Abstract.** Road sector development policy in Bangka Belitung emphasis on equitable development, which is opening up new areas for industrial development zones of potential marine and coastal tourism, so that having an impact on the budget priority to build a new road. This led to a minimal budget provided for the maintenance of the existing road. This study aimed to evaluate the condition of the pavement both functionally and structurally, the growth of traffic density and the availability of existing road maintenance costs. Then, to analyze the influence of existing road conditions, traffic density and road maintenance costs to the type of road maintenance management. The results are compared with the results of the existing maintenance conducted by the Public Works Department of Bangka Belitung province. Evaluation of pavement conditions consists of visual assessment of pavement condition using IRI, pavement condition assessment functionally with deflection method using test data tool Benkelman Beam (BB) and the actual traffic load. IRI value, deflections and traffic growth gained from years 2011-2015 subsequently created regression models to obtain the relationship and the correlation coefficient. The analysis showed that using the same relative magnitude of the budget from 2011 to 2015, giving priority to the maintenance of the road with good conditions capable of providing the road with a steady state of 100%. Recommendations can be given that maintain the road with good conditions reflecting that preservation provide maximum results with the more efficient maintenance cost.

## 1. Introduction

Roads are the transport infrastructures which play an important role in supporting the economic growth of a region. Therefore, it is necessary to do maintenance efforts so that the roads can function optimally. Road sector development policy in Bangka Belitung emphasis on equitable development, which is opening up new areas for development of industrial zones of potential marine and coastal tourism, so that having an impact on the budget priority to build new roads. This led to a minimal budget provided for the maintenance of the road. Assessment of road pavement conditions is the important aspects to determine the maintenance activities for road improvement. To carry out the assessment of pavement condition, the first is to determine the types of damage, the density as well as the level of severity.

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This study aimed to evaluate the condition of the pavement both functionally and structurally, the growth of traffic density and the availability of road maintenance costs. Then analyze the influence of road conditions, traffic density and road maintenance costs to the type of road maintenance management. The results are compared with the results of the existing maintenance conducted by the Public Works Department of Bangka Belitung province. Condition assessment pavement is aimed at giving information pavement condition at a particular time. Based on the information gathered will be used to establish kinds of the study, the assessment of priorities, and maintenance programs [1]. Early research to situations the road surface is to carry out visually survey by means of seeing and analyze damage on the basis of with damage level for use as a basis for engaging in the maintenance and repair [2]. The functional pavement analysis is done on the flexible pavement based on the road conditions .The relationship obtained an exponential inclination and can be used to predict the service life of pavement of [3]. The principle road maintenance done with economic benefits effective and efficient, through budget minimum can be produced road conditions steady so that the community happy as the costs of being inferior transport [4].

## 2. Experimental

### 2.1. International Roughness Index (IRI)

Flatness level road (International Roughness Index, IRI) is one parameter used to determine the level of service a condition that affects the road driver comfort (riding quality). The main requirement is a good way strong, flat, waterproof, durable and economical over the life of the plan. To meet the requirements of monitoring and evaluation needs to be done regularly so that it can be determined that the proper method of construction improvements. To determine the level of the road surface flatness measurements can be performed using the method recommended by NAASRA.

### 2.2. Testing with Benkelman Beam

Benkelman beam instrument was used to measure the deflection. The turning deflection (rebounds deflection) has been the large deflection vertical synchronization the impact on the point of observation, deflection travelers commonly used to design the pavement thickness.

The procedure calculation deflection method using the BB (Benkelman Beam) is based on the standard Pd.Tt-05-2005-B as follows:

A. The burden of determining repetition of traffic plan (CESA) in ESA.

- a. Determine traffic and coefficients distribution vehicles (C), Table 1 shows the determination of the number of lines based on the width of pavements. Table 2 shows the determination of C the value based on the number of line and traffic direction.

**Table 1.** The number of lanes and width of pavement

Wide of Pavement (L)	The number of lanes
$L < 4.50 \text{ m}$	1
$4.50 \text{ m} \leq L < 8.00 \text{ m}$	2
$8.00 \text{ m} \leq L < 11.25 \text{ m}$	3
$11.25 \text{ m} \leq L < 1.00 \text{ m}$	4
$15.00 \text{ m} \leq L < 18.75 \text{ m}$	5
$18.75 \text{ m} \leq L < 22.50 \text{ m}$	6

**Table 2.** Vehicles Distribution coefficient (C)

The number of lanes	Minor vehicle*		Heavy vehicle*	
	1 direction	2 directions	1 direction	2 directions
1	1.00	1.00	1.00	1.00
2	0.60	0.50	0.70	0.50
3	0.40	0.40	0.50	0.475
4	-	0.30	-	0.45
5	-	0.25	-	0.425
6	-	0.20	-	0.40

b. Determine the vehicle equivalent axis (E)

$$\text{Equivalent Number STRT} = \left( \frac{\text{axle load (ton)}}{5,40} \right)^4 \dots \dots \dots (1)$$

$$\text{Equivalent Number STRG} = \left( \frac{\text{axle load (ton)}}{8,16} \right)^4 \dots \dots \dots (2)$$

$$\text{Equivalent Numbern SDRG} = \left( \frac{\text{axle load (ton)}}{13,76} \right)^4 \dots \dots \dots (3)$$

$$\text{Equivalent Number STrRG} = \left( \frac{\text{axle load (ton)}}{18,45} \right)^4 \dots \dots \dots (4)$$

c. Determining factor age plans and growth of traffic (N)

$$N = \frac{1}{2} \left[ 1 + (1 + r)^n + 2(1 + r) \frac{(1 + r)^{n-1} - 1}{r} \right] \dots \dots \dots (5)$$

d. Accumulation of equivalent burden the axis standard (CESA)

$$CESA = \sum_{Tractor-Triler}^{MP} m \times 365 \times E \times C \times N \dots \dots \dots (6)$$

B. Count the results of the testing deflection and corrections by a factor of advance ground water (ca) and factor of temperature standard (ft) as well as bb test factors if the burden of proper test worth 8.16 tons

$$d_B = 2 \times (d_3 - d_1) \times Ft \times Ca \times FK_{B-BB} \dots \dots \dots (7)$$

C. Determine the length of section of segments having uniformity (FK) in line with the rate uniformity a license which desired in accordance guidelines.

$$FK = \frac{S}{d_r} \times 100\% < FK_{ijin} \dots \dots \dots (8)$$

$$dr = \sum_{\frac{1}{n_s}}^{n_s} d \quad \dots\dots (9)$$

$$S = \sqrt{\frac{n_s(\sum_1^{n_s} d^2) - (\sum_1^{n_s} d)^2}{n_s(n_s-1)}} \quad \dots\dots(10)$$

D. Counting deflection vice (  $D_{vice}$  ) for each road section that relies on the class of the road

$$D_{vice} = d_R + 2s \quad \dots\dots(11)$$

$$D_{vice} = d_R + 1,64s \quad \dots\dots(12)$$

$$D_{vice1} = d_R + 1,28s \quad \dots\dots(13)$$

E. Counting deflection plan permission (  $D_{planning}$  )

$$D_{planning} = 22,208 \times CESA^{(-0,2307)} \quad \dots\dots(14)$$

### 2.3. The Location of Study

The location of the study was in the segment of the National Highway from Batas Kota Pangkal Pinang to Puding Besar with the length of 22,682 Km. The segment of highway has the function of primary collector and class II type of highway in Indonesia.

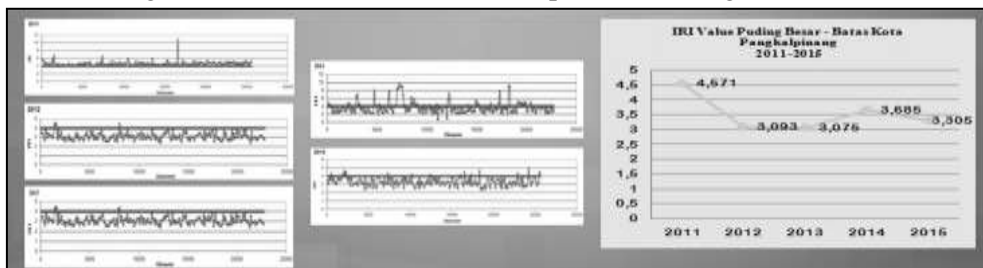
### 2.4 The Methods

- A. In this study, first collected data as follows:
  - a. Functional condition
  - b. Structural condition
  - c. Traffic data
  - d. Cost maintenance and rehabilitation pavement
- B. Next up is evaluating each data from 2011 – 2015
- C. The last, compared with the results of the existing maintenance conducted by the Public Works Department of Bangka Belitung province.

## 3. Results and discussion

### 3.1 The evaluation of functional pavement condition

The evaluations of functional road conditions were carried out using NASRA Equipment to measure the International Roughness Index (IRI), the results are presented in Figure 1.

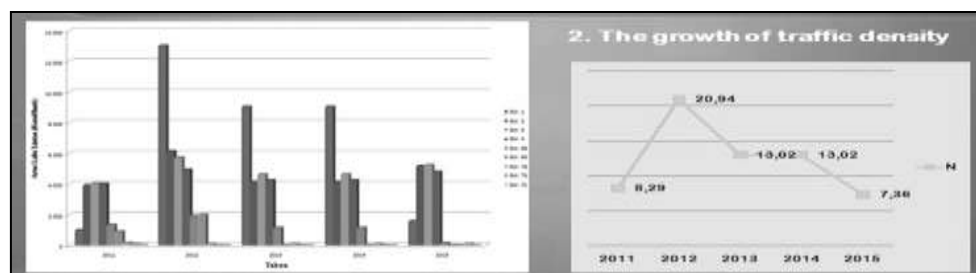


**Figure 1.** Result of functional road condition 2011-2015

It could be seen from the figure that the condition in 2011 is 'medium' for road condition and in the year of 2012 to 2015 performed the 'good' road condition.

### 3.2 The growth of traffic

The volume of traffic passing through the segment of Batas Kota Pangkalpinang to Puding Besar could be seen in Figure 4, where there was decreasing volume of traffic caused by impairment in the functions of port nearby. The traffic congestion in the road segment to Tanjung Kelian Port of Pangkalpinang city. Consequently, the traffic decreases up to the year of 2015 when the national roads have been improved. Since then, the traffic increase significantly. The data of traffic growth are presented in Figure 2.



**Figure 2.** The growth of traffic from 2011 to 2015

### 3.3 The Evaluation of structural condition

The data from Bengkelmen beam were then analyzed to determine the overlay required for the segmented road. The results are presented in Figure 3. The overlay needed from 2011 to 2015 are presented in Figure 4.

Year	Average Deflection (dR)	Standard Deviation (s)	Uniformity Deflection (FK)	Representative Deflection (Dwakil)	Deflection permission plan (Drencana)	Added thick layers (Ho)	Thick layers correction (Fo)	Thick layers added corrected (Ht)	Plan Add Layer Thickness
2011	0,83	0,10	12,41	0,999	0,361	17,64	1,00	17,64	3,00
2012	1,29	0,24	18,64	1,683	0,342	27,28	1,00	27,28	4,60
2013	1,23	0,29	23,42	1,699	0,387	25,37	1,00	25,37	4,30
2014	1,23	0,22	17,83	1,590	0,387	24,26	1,00	24,26	4,00
2015	1,23	0,22	17,83	1,590	0,332	26,82	1,00	26,82	4,50

**Figure 3.** The result of using Benkelman Beam 2011-2015



**Figure 4.** The thickness of overlay layers 2011-2015

### 3.4 Maintenance program has to be done by the Public Works Departement of Bangka Belitung Province

The type of maintenance and rehabilitation program and the respective cost for each type of treatment are presented in Figure 5.

Public Work Departemen					
Program	Cost maintenance (Rp)				
	2011	2012	2013	2014	2015
Routine	508.560.000	793.870.000	771.188.000	839.234.000	861.916.000
Periodic	972.555.672	-	-	-	-
Reconstruction	-	-	-	-	6.583.100.000

**Figure 5.** Cost maintenance 2011-2015

From 2011 to 2015 is the implementation of the program on the road. Whether it is routine program, periodical or reconstruction

### 3.5 Compare the results of existing maintenance conducted by the Public Works Department of Bangka Belitung Province

The results of road condition depend on the maintenance program carried out, as can be seen from Figure 6, the road maintenance program is the best choice for highway management.

IRI Value						Deflection Data					
Recomend program	2011	2012	2013	2014	2015	Recomend program	2011	2012	2013	2014	2015
Routine	-	V	V	V	V	Routine	-	-	-	-	-
Periodic	V	-	-	-	-	Periodic	V	V	V	V	V
Reconstruction	-	-	-	-	-	Reconstruction	-	-	-	-	-

Public Work Departemen					
Program	Cost maintenance (Rp)				
	2011	2012	2013	2014	2015
Routine	508.560.000	793.870.000	771.188.000	839.234.000	861.916.000
Periodic	972.555.672	-	-	-	-
Reconstruction	-	-	-	-	6.583.100.000

**Figure 6.** Comparison result between IRI, Planning an overlay thickness and maintenance cost

Based on IRI value, deflection and growth of traffic, it can be seen parameter used as the best activities is IRI value

## 4. Conclusion

The results of the analysis indicate that using the same relative magnitude of the budget from 2011 to 2015 by giving the priority to the road maintenance at relatively good conditions are efficient of providing the road with a steady state of 100%. Recommendations can be given that maintain the road with good conditions reflecting that preservation provide maximum results with more efficient maintenance cost.

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