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Analysis of the use of Adjustment Pads in Fine Adjustment of Geometry Settlement in Ballastless Track of Jakarta-Bandung High Speed Train (Case Study: K63+016~K63+035 Tegalega Area, Karawang, West Java)

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Abstract: On the ballastless track K63+016~K63+035 of the Jakarta-Bandung High Speed Railway (JBHSR) there is a decrease in geometry with the category of damage level reaching the limit set according to Regulation No. 11 PT KCIC Year 2023. The event was mostly caused by the irregularity of the lower structure due to dynamic loads. The procedure used is to perform fine adjustment using an adjustment pad according to the regulations listed in SOP No. 17 PT KCIC Year 2021 so that the decline can be overcome. Testing the effectiveness of using adjustment pads on geometry decline through hypothesis testing with the F test and t-test methods can determine how much influence between the two. The results of the analysis obtained a correlation value (r) of 0.965 and a p-value of 0.000 <0.05 indicating that the use of adjustment pads has a very significant effect and a very strong correlation on geometry reduction.

Keywords: KCJB, Geometry Decrease, Ballastless, Fine Adjustment, Adjustment Pad

INTRODUCTION

The construction of the Jakarta-Bandung High Speed Train (KCJB) or commonly known as “WHOOSH” by PT KCIC proves a significant progress in the development of transportation modes in Indonesia, especially in the railway sector. The train, which was built with an operational speed of up to 350 km/h, is included in the fast train in accordance with the Regulation of the Minister of Transportation of the Republic of Indonesia Number 7 of 2022 concerning the Implementation of High Speed Railways. According to the PM, it is explained that a High Speed Train is a train that has a speed of more than 200 km/h. Whoosh with type CR400AF officially operates in October 2023 and connects Jakarta-Bandung along 142.3 km with four transit stations and one depot namely Halim Station, Karawang Station, Padalarang Station, and Tegalluar Station and Depot which can be reached within 30 to 45 minutes. In supporting the stop, connecting trains are provided at 2 stations, namely Halim

Station which is integrated with Jabodebek LRT and Padalarang Station which is integrated with the Garut Commuter Line, Bandung Raya Commuter Line, and Feeder Train from Padalarang Station to Bandung Station which is only 15-20 minutes away.

The Jakarta-Bandung High Speed Rail has not been in operation for one year. However, in 2024, there has been a decrease in rail geometry on the ballastless track at K63+016 ~ K63+035 caused by many factors such as changes in the subgrade structure, loads from repeated train traffic, construction errors, and damage or failure of supporting structures that cause irregularities in rail geometry. This will have an impact on train operations, including a decrease in the speed of fast trains, instability and unevenness on the rail line which can increase the risk of accidents, reduced passenger comfort because they can feel shocks during travel, and further damage to other components due to uneven loads.

The step that can be taken to overcome these impacts is to elevate the railroad that has decreased. The elevation or fine adjustment is done by installing an adjustment pad on the K63+016~K63+035 ballastless track. Adjustment pad is an important component used to adjust the railroad height caused by misalignment to get fine adjustment (railroad elevation). This component has various types and sizes according to the required specifications. Installation is done by considering the challenges that must be faced in terms of planning and maintenance in order to get opportunities to improve the efficiency and effectiveness of using adjustment pads against geometry deterioration on ballastless tracks. By considering the challenges faced and opportunities for increased efficiency, the use of adjustment pads in fine adjustment on the ballastless track can support the operational performance of the Jakarta-Bandung High Speed Train or Whoosh. The use of adjustment pads on the tether plays an important role in influencing the stability and comfort of the Jakarta-Bandung high-speed train operation through optimal use.

Literature Review

Table 1 Previous Research

Research title	Definition	Source
Railway Track Geometry Defects and Deterioration	Inspect railroad geometry defects and investigate causes and maintenance methods Discusses the effect of variations in rail pad stiffness and speed on rail forces on railroads To estimate the growth of concrete cracks under the dynamic load of trains based on the number of passing vehicles	Chebaran Jonex, Sibomana Aime Aliphones, Zewdie Moges (2022)
Effect of rail pad stiffness on the wheel/rail force intensity in a railway slab track with short-wave irregularity		Qingsong Feng, Kui Sun, Hua-Peng Chen, Xiaoyan Lei (2021)
Long-term prediction of fatigue crack growth in ballastless track of high-speed railway due to cyclic train load		Amin Khajehdezfuly (2019)

Analysis of Rail Bearing Usage on Railway Lines	Analyze rail bearing types on load characteristics, resistance to working moments, and deflection to evaluate whether the use of rail bearings is appropriate or not and look for the most suitable rail bearings	Muhammad Chusnul (2023)
Evaluation of Damage to Rail Road Along - Boharan KM 24+167 - KM 33+867	Knowing the causes and impacts of damaged train components such as deformed rails, broken sleepers, missing fastening, lack of ballast volume that will reduce train service quality	Habibullah Kamil Sukra (2021)

METHOD

Researchers collected data in 3 ways, including making observations to find out directly the conditions on the ballastless track of the Jakarta-Bandung High Speed Train, documentation to collect data in the form of photos and videos, and literature studies as relevant supporting references. The data collection process produces 2 types of data, namely primary data and secondary data. The data is generated through a series of pre-planned methods and used to further analyze the research. By utilizing both types of data, researchers can obtain a more comprehensive and in-depth picture of the conditions that exist in the field.

a. Primary Data
   Primary data used in this study comes from field observations to see the direct condition of the geometry decline that occurs and perform fine adjustment procedures at the point where railroad irregularities occur.
b. Secondary Data
   Secondary data is used to find other sources of data or information that support research and come from companies or other institutions (indirectly).

The researcher collected data from various sources and types relevant to the study. Furthermore, it was analyzed in depth to understand the use of adjustment pads in the fine adjustment procedure in overcoming geometry decline at K63+016~K63+035. Data analysis is used to interpret the data that has been obtained from the results of data processing. Through data analysis, researchers can confirm and find results to identify the problem being studied. Without proper analysis, the existing problems will not be answered, making it difficult to take effective action. This research was analyzed using the Pearson correlation analysis method, f test, and t-test. The three methods are used to determine the strength of the relationship and effectiveness between the use of adjustment pads on geometry decline with the independent variable used is the use of adjustment pads and the dependent variable is geometry decline.

RESULT AND DISCUSSION

Based on the results of Dynamic Inspection conducted by Comprehensive Inspection Train (CIT), the value is -7.14 mm and Static Inspection with Track Measurement Geometry (Gedo Trimble) gets a value of -6~-9.1. This decrease in geometry is caused by ground settlement or movement, vibration and dynamic loads, cross level, track gauge, elevation, absolute deformation, irregularity of the bottom structure. Therefore, the geometry defect of K63+016~K63+035 Ballastless Track falls into the Level I deviation category according to the following table:

a. Dynamic Inspection

Item		Routine maintenance	Planned maintenance	Temporary repair	Speed limit (200 km/h and below)
Level of deviation		Level I	Level II	Level III	Level IV
Track gauge (mm)		+4 -3	+6 -4	+7 -5	+8 -6
Cross level (mm)		5	6	7	8
Twist (baseline length: 3 m) (mm)		4	6	7	8
Longitudinal level (mm)	Wave length: 1.5-42 m	4	6	8	10
Track alignment (mm)		4	5	6	7
Longitudinal level (mm)	Wave length 1.5 m to 120 m	7	9	12	15
Track alignment		6	8	10	12

b. Static Inspection

Item	*Maintenance Acceptance*	Perawatan terencana (*Planned maintenance*)	Perawatan tidak terjadwal (*Temporary repair*)
Longitudinal level	7	11	15
Track alignment	5	9	14

Data Analysis of the Effect of Using Adjustment Pad on Geometry Decrease

The results of data processing on the use of adjustment pads and geometry reduction with three methods are as follows:

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	113.458	1	113.458	244.815	.000[b]
	Residual	8.342	18	.463		
	Total	121.800	19			

a. Dependent Variable: Penurunan Geometri

b. Predictors: (Constant), Penggunaan Adjustment Pad

Pearson correlation shows a value of 0.965 indicating that there is a positive linear relationship or a very strong correlation between the two variables, because the value is close to the maximum value = 1.

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	26.444	1.640		16.128	.000
	Penggunaan Adjustment Pad	.313	.020	.965	15.647	.000

a. Dependent Variable: Penurunan Geometri

Based on the F-test results, with an F-value of: 244.815 and P-value: 0.000 <0.05 shows that statistically, the relationship between the use of adjustment pads has a very significant influence on geometry decline.

Correlations

		Penggunaan Adjustment Pad	Penurunan Geometri
Penggunaan Adjustment Pad	Pearson Correlation	1	.965**
	Sig. (2-tailed)		.000
	N	20	20
Penurunan Geometri	Pearson Correlation	.965**	1
	Sig. (2-tailed)	.000	
	N	20	20

**. Correlation is significant at the 0.01 level (2-tailed).

Based on the results of the t-test which shows that the p value <0.05 and t> p-value is very high indicating that it is highly significant. The value of $p < 0.05$ indicates that between the two variables is highly statistically significant.

Fine Adjustment Procedure

According to the results of the railroad inspection using the Comprehensive Inspection Train (CIT), it was noted that there was a decrease in railroad geometry on the ballastless track at K63+016~K63+035. Therefore, a fine adjustment needs to be carried out by the permanent way bureau to eliminate track irregularities. The number of work personnel is at least 7 people. After the track alignment deviation is found by track geometry measurement (gedo trimble), the railroad position should be adjusted according to the data of the exact adjustment plan results to return to the initial position and provide maintenance standards for fine adjustment.

Railroad Maintenance

Maintenance is an activity carried out to maintain the reliability of Railway Facilities to remain fit for operation (PM No. 7 of 2022). Railway maintenance must be carried out to maintain the results of using the adjustment pad in fine adjustment because it is related to the safety and durability of construction.

The railroad must be maintained in an ideal standard state. Railroad maintenance includes damage repair and structural repair. In addition, ballastless construction is more rigid than ballasted, meaning high rigidity and minimal flexibility. Therefore, when the initial construction is strong, the settlement on the track (horizontal and vertical) is less than ballasted.

a. Planned Maintenance
    1. Preventive Maintenance: identifying problems early so as to prevent damage and taking the necessary corrective action before they become serious and significantly affect operations. This maintenance is essential to maintain railroad safety, reliability and operational efficiency.
        - Conducting inspections (dynamic and static) at the prescribed cycle or frequency to ensure there is no damage or wear, as well as measuring track gauge and cross level periodically.
        - Monitoring the condition of the railroad on a regular basis to detect problems so that early repairs can be carried out at the light damage level to prevent it from entering the heavy damage level.
        - Conduct visual inspections to detect any damage or discrepancies in adjustment pads or other railroad components. In addition, it can identify potential weaknesses or damage to critical railroad parts.

- Long-term maintenance to ensure the strength and stability of the railroad structure after the fine adjustment is performed.

2. Corrective Maintenance (Repair): activities carried out after damage or disturbance occurs. This maintenance is carried out in response to problems that occur.
   - Repair or replacement of materials in the event of damage to railroad components such as track slab damage, tethers, etc.
   - Performing fine adjustment with adjustment pads according to the required technical specifications. Replace damaged or worn adjustment pads with new, high quality ones to improve stability and re-fine adjustments if significant discrepancies are found during inspection.
   - Strengthening the foundation by reinforcing the soil so as to maintain the stability and strength of the foundation.

b. Unplanned Maintenance

Corrective actions taken due to emergency or unpredictable problems after fine adjustment has been carried out. Although unplanned, this maintenance must be carried out as soon as a problem is detected to prevent potential further damage or disruption of operations on the train. So as to maintain the operational efficiency of high-speed trains, ensure safety, and maintain good service quality for passengers.

Carrying out rail maintenance to maintain the adjustment pads in fine adjustment is a critical step to ensure the safety, operational efficiency, and longevity of rail infrastructure. Proper maintenance helps prevent accidents, extends component life, and maintains service and operational quality. In addition, maintenance ensures safety standards and helps deal with environmental challenges that can affect rail stability and performance.

CONCLUSION

Based on the analysis and discussion that has been carried out in the research, the following conclusions can be drawn:

a. The results of the analysis show that the use of adjustment pads has a very significant effect and a very strong correlation to the decrease in railroad geometry on the ballastless track K63+016 ~ K63+035. This is evidenced by the correlation value (J) of 0.965 and p value: < 0.05 indicating a very strong and statistically significant correlation, thus supporting the effectiveness of the fine adjustment process.

b. The fine adjustment procedure consists of several stages starting from measurement and review, preparation of work, implementation of fine adjustment, final quality check and securing the area until exiting the site and reporting maintenance results By following this procedure, the settlement of railroad geometry on the K63+016~K63+035 ballastless track can be effectively addressed and ensure the safety and convenience of high-speed rail operations.

c. The geometry deterioration was caused by several factors which were mainly caused by the irregularity of the lower structure due to vibration and dynamic loads resulting from the frequency of passing trains, so fine adjustment must be performed. In maintaining the fine adjustment results, an optimal maintenance strategy must be carried out, namely planned and unplanned maintenance.

Implications

a. Gaining new insights and helping to develop theory and provide benefits in the field of railways, especially fast trains in providing references regarding the use of adjustment pads in fine adjustment to the decline in the geometry of the ballastless track of the Jakarta-Bandung High Speed Train

b. It is expected to apply the knowledge that has been obtained and can be useful for the railway field

c. It is hoped that this research can be used as a reference for reading material and as input to readers who will or are conducting research both related and unrelated to the topic of this research

Research limitations

Based on the results and conclusions of this study, there are several suggestions, among others:

a. Coordination between the various parties involved in analyzing the results of dynamic inspections with gedo trimble is further enhanced
b. The company must pay attention to the availability of tools and components in fine adjustment activities
c. Conduct regular evaluations of the results of fine adjustment to maintain the quality and condition of the railroad
d. Future researchers are expected to analyze the causes of geometry decline on the ballastless track in more depth so that they can carry out prevention and maintenance activities more effectively

REFERENCES

Rosyidi, S. A. P. (2015). *Rekayasa Jalan Kereta Api: tinjauan struktur jalan rel* (I).

Rules for Maintenance of Track Infrastructure of Jakarta-Bandung High Speed Railway Reviewed by (CR-Beijing). (2023).

Beijing, C. (2021). *SOP 17 Pedoman Perawatan Fine Adjustment Jalur Ballastless*. Dwiatmoko, H. (2013). *Keselamatan Jalur & Bangunan Kereta Api* (Edisi Pertama). Kencana. Dwiatmoko, H. (2017). *Pembangunan Jalur Kereta Api Trans-Sulawesi* (A. H. Khrisna & D.

K. Gunawan, Ed.; Edisi Pertama). Kencana.

Jonex, C., Aime Aliphones, S., & Moges, Z. (2022). Railway Track Geometry Defects and Deterioration, a Literature Review. Dalam *International Journal of Engineering and Applied Sciences (IJEAS)* (Nomor 9). www.ijeas.org.

Thompson, D. (2008). *Railway noise and vibration: mechanisms, modelling and means of control*.