Evaluating the Calculation of Rail Road Components and Maintenance Cycle on the Temporary Track of Construction Project

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Abstract. The construction of a Temporary Track or temporary rail line aims to ensure that the construction of the elevated rail at Joglo Solo intersection does not interfere with train operations and travel, so it is necessary to identify and evaluate whether the component materials used are by the provisions of the technical specifications of PM No. 60 of 2012 and the annual cross load. In addition, maintenance cycle planning based on the results of calculations and evaluations is needed to determine the appropriate treatment items based on PM No. 32 of 2011. Evaluation of the Temporary Track of the Joglo Solo Intersection is carried out by calculating the carrying capacity of the crossing/passing tonnage in a year which aims to determine the class of the railroad. Then perform calculations on rail tension based on the required rail class and calculation of sleeper tension. An inspection of the ballast component based on visual conditions and laboratory test results is needed to determine the condition of the component so that, in the end, it can determine the appropriate maintenance cycle. Based on the results of the quick calculation, the Joglo Solo intersection is a class II train line. With a passing tonnage of 12.2 million tons/year. The essential allowable tension of the rail does not appropriate the requirements of 1141,896 1128 kg/cm^2. Wijaya Karya (Wika) Beton sleepers have met the requirements based on tension calculations. From the results of laboratory tests on the ballast compressive strength test's ballast component, it does not appropriate the requirements because it has a compressive strength value above 1000 kg/cm^2. Based on the evaluation results, the appropriate maintenance cycle based on PM No. 32 of 2011 is daily and monthly maintenance.

Keywords: Railway Temporary Track · passing tonnage · Inspection · Maintenance

1 Introduction

The construction of a double track railroad is a project that aims to support progress in the fields of transportation, economy, and tourism. One of the ongoing projects is the Solo-Semarang Double Track Project which is divided into several phases, one of which is the

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construction of a 1.8 km elevated rail at Joglo Solo Intersection. The project disrupted train travel. Therefore, to overcome this problem, a Temporary Track was built next to the existing Joglo Solo intersection so that a rail component is needed in accordance with the provisions of the technical specifications in the Minister of Transportation Regulation Number 60 of 2012.

The Joglo Solo intersection has a fairly congested train frequency because it is passed by long-distance trains, both passengers and goods, and the BIAS airport train and is a congestion point in the city of Solo. With this flyover project, it is expected to be able to organize transportation and solve traffic problems and train movement by identifying and evaluating component materials and calculating passing tonnage, the maintenance cycle that should be carried out according to the specified standards.

The purpose of this study was to calculate the annual cross-carrying capacity on the Temporary Track of the Joglo Solo Intersection, evaluate the component material of the Temporary Track of the Joglo Solo Intersection in accordance with the calculations and provisions of the technical specifications in Ministerial Regulation No. 60 of 2012, and recommend an appropriate maintenance cycle based on Ministerial Regulation No. 32 of 2011.

2 Research Methods

Data processing is primary data, namely component damage data that is processed to identify the condition of rail components and rail road maintenance needs in accordance with regulations, as well as secondary data in the form of train travel graphs and stamformation data which are processed to obtain the calculation results of passing tonnage at the Joglo Solo Intersection Temporary Track; Rail, sleeper, fastening, and ballast materials from the Temporary Track are processed to obtain the calculation results of allowable tension, rail base tension, and sleeper tension, as well as laboratory test results.

The data analysis method is carried out by calculating the passing tonnage year to find out the existing rail class according to the specifications of the Minister of Transportation Regulation No. 60 Year 2012 from the results of Train travel chart (Gapeka) and Stamformation data processing (PT Kereta Api Indonesia):

$$\text{Weight of Each Train} = \text{Number of Circuits} \times \text{Circuit Weight} \tag{1}$$

$$(\text{Pd}) = (\text{Tp}) + (\text{Tb}) \tag{2}$$

$$\text{T} = 360 \times \text{S} \times \text{TE} \tag{3}$$

$$\text{TE} = \text{Tp} + (\text{Kb} \times \text{Tb}) + (\text{K1} \times \text{T1}) \tag{4}$$

Pd = Daily Rail Load (tons); Tb = daily tonnage of goods and carriages (tons); Tp = Daily passenger and train tonnage (tons); T = Cross-carrying capacity (tons/year); TE = Tonnage equivalent (tons/day); Tp = Daily passenger and train tonnage; Tb = daily tonnage of goods and carriages; T1 = Daily Locomotive Tonnage; S = Coefficient

whose magnitude depends on the quality of the traffic, namely: 1.1 for passenger train traffic with a maximum speed of 120 km/h, and 1.0 for traffic without passenger trains; Kb = Coefficient whose magnitude depends on the axle load, namely: 1.5 for axle load <18 t, and 1.3 for axle load >18 t; K1 = Coefficient whose magnitude is determined to be 1.4.

The results of the rail material specification data processing were analyzed to use and calculate the allowable tension and base tension of the rail in accordance with the applicable provisions (Rosyidi, 2015):

$$\text{Ma} = 0{,}85\frac{Pd}{4\gamma}, \text{ if wheel configuration is not taken into account}$$

$$\text{Ma} = 0{,}75\frac{Pd}{4\gamma}, \text{ for BB locomotive}$$

$$\text{Ma} = 0{,}82\frac{Pd}{4\gamma} \text{for CC locomotive} \tag{5}$$

$$\text{Pd} = \text{Ps}[1 + 0{,}01\left(\frac{vplan}{1{,}069} - 5\right) \tag{6}$$

$$\boldsymbol{\gamma} = \sqrt[4]{\frac{K}{4EI}} \tag{7}$$

$$\sigma = \frac{MaXy}{Ix} \tag{8}$$

$$Sbase = \frac{Ma}{Wb} \tag{9}$$

K = modulus of rail/track stiffness; Pd = wheel dynamic load; Ps = Static wheel load; Vr = design speed (km/h); I = Moment of Inertia; $\boldsymbol{\gamma}$ = damping factor; E = modulus of elasticity of rail; σ = allowable tension for road class; Sbase = allowable tension at the base of the rail; Ma = moment on the sleeper side up; Wb = moment of sleeper resistance under side; Y = the location of the neutral line.

The results of the data processing of the technical specifications of the sleepers to obtain the sleeper values on the Joglo Solo Intersection Temporary Line (Rosyidi, 2015):

$$\text{E} = 6400\sqrt{fcu} \tag{10}$$

$$\text{Q} = 60\% \text{ PD} \tag{11}$$

$$Mcd = \frac{Q}{4\gamma}\frac{1}{Sin\ \gamma L + Sinh\,\gamma L}[2cosh^2\gamma a(cos2\gamma c + cosh\gamma L) - 2cos^2\gamma a(cosh2\gamma c + cos\gamma L) - sinh2\gamma a(\sin 2\gamma c + \sinh\gamma L) - \sin2\gamma a(\sinh 2\gamma c + \sin\gamma L) -] \tag{12}$$

$$Mo = \frac{Q}{2\gamma}\frac{1}{Sin\ \gamma L + Sinh\,\gamma L}[sinh\,\gamma c(sinc(sin\gamma c + sin\gamma(L-c)) + sin\,\gamma c(sinh\gamma c + sinh(L-c)) - cosh\gamma c\,cos\gamma(L-c)$$

$$- cos\gamma c \cosh \gamma \ (L - c)] \tag{13}$$

$$\mathrm{P_{initial}} = \sigma\mathrm{break} \times \mathrm{A_{prestressed\ steel}} \tag{14}$$

$$\text{The upper side of the lower part of the rail: } \sigma = \frac{Pinitial}{A1} - \frac{Pinitial.e}{W1a}, \mathrm{e} = 0{,}135 \tag{15}$$

$$\text{Lower side of the rail: } \sigma = \frac{Pinitial}{A1} - \frac{Pinitial.e}{W1b}, \mathrm{e} = 0{,}135 \tag{16}$$

$$\text{Upper side of the center of the Sleeper: } \sigma = \frac{Pinitial}{A2} - \frac{Pinitial.e}{W1a}, \mathrm{e} = 1{,}055 \tag{17}$$

$$\text{The lower side of the Center of the Sleeper: } \sigma = \frac{Pinitial}{A2} - \frac{Pinitial.e}{W1b}, \mathrm{e} = 1{,}055 \tag{18}$$

$$\mathrm{P\ effective} = \mathrm{P\ intial}(1 - \mathrm{R}) \tag{19}$$

$$\text{The upper side of the lower part of the rail: } \sigma = \frac{Peffektive}{A1} - \frac{Peffektive.e}{W1a} + \frac{M}{W1a}e = 0{,}135 \tag{20}$$

$$\text{Lower side of the rail: } \sigma = \frac{Peffektive}{A1} - \frac{Peeffektive.e}{W1b} + \frac{M}{W1b},\ e = 0{,}135 \tag{21}$$

$$\text{Upper side of the center of the Sleeper: } \sigma = \frac{Peffektive}{A2} + \frac{Peffektive.e}{W1a} - \frac{M}{W1a},\ e = 1{,}055 \tag{22}$$

$$\text{Lower side of Sleeper Center: } \sigma = \frac{Peffektive}{A2} - \frac{Peffektive.e}{W1a} + \frac{M}{W1a},\ e = 1{,}055 \tag{23}$$

E = Modulus of elasticity; Fcu = Concrete Quality Value; $\boldsymbol{\gamma}$ = Damping factor; Ix = Moment of inertia of the rail about the x – x axis; M = Moment on sleeper; Pd = Dynamic load of the vehicle; Q = Load that can be accepted by the sleeper; W = Moment of resistance; A = Sleeper Area according to Field Specifications;

The results of the fastening and ballast specification data are processed to determine the condition of the components based on the inspection and test results; and from all evaluations can recommend maintenance cycles on the Temporary Track based on the Minister of Transportation Regulation No. 32 of 2011.

3 Result

3.1 Passing Tonage

Based on the Minister of Transportation Regulation No. 60 of 2012 the maximum axle load for a width of 1067 mm is 18 t. The Kb value used is 1.5 and the KI value is 1.4.

Table 1. Calculation result of Allowable tension and Rail base tension

Item	Requirements	Results	Description
Allowable tension (kg/cm^2)	≤1325 kg/cm^2	1142,364	Appropriate
Rail base tension (kg/cm^2)	≤1128 kg/cm^2	1141,896	Not Appropriate

TE = Tp + (Kb × Tb) + (K1 × Tl) = 13483 + (1.5 × 9744) + (1.4 × 1992) = 30887.8 t/day.

T = 360 × S × TE (S = 1.1 Due to the maximum speed of 120 km/h) = 360 × 1.1 × 30887.8 = 12231568.8 *t*/Year.

T = 12.2 Million Ton/Year.

The calculation result of the passing tonnage on the Temporary Track of the Joglo Solo Intersection is 12.2 million tons/year, so that based on the Minister of Transportation Regulation No. 60 of 2012 it can be seen that the Joglo Solo Intersection Temporary Track is included in rail road class II.

3.2 Calculation of Temporary Track Components: Rail Tension

$$\mathrm{Pd} = 7500[1 + 0{,}01(\frac{137{,}5}{1{,}069} - 5)] = 16772\,\mathrm{kg}$$

$$\gamma = \sqrt[4]{\frac{180}{4 \times 2{,}1 \times 10^6 \times 2346}} = 0{,}009776\ \mathrm{cm}^{-1}$$

$$Ma = 0{,}82\frac{Pd}{4\gamma} = 0{,}82\frac{16772\,\mathrm{kg}}{0{,}039104\,\mathrm{cm}^{-1}} = 351740{,}173\ \mathrm{kgcm}$$

$$\sigma = \frac{351740{,}173\,\mathrm{kgcm} \times 7{,}620\,\mathrm{cm}}{2346\,\mathrm{cm}^4} = 1142{,}364\ \mathrm{kg/cm^2} 1325\ \mathrm{kg/cm^2}$$

$$Sbase = \frac{Mall}{Wbll} = \frac{351740{,}173\,\mathrm{kgcm}}{308\,\mathrm{Cm}^2} = 1141{,}8961128\ \mathrm{kg/cm^2}$$

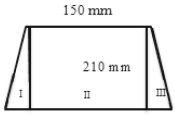
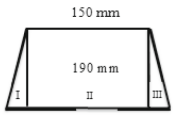
From Table 1 it can be seen that the allowable tension value has met the requirements based on the Regulation of the Minister of Transportation No. 60 of 2012 which is 1325 kg/cm^2. While the Rail base tension value does not appropriate the specifications based on PM 60 of 2012 which is 1141,896 kg/cm^2 exceeding the provision of 1128 kg/cm^2, so in this research will provide advice regarding maintenance based on the calculation results and refer to the Regulation of the Minister of Transportation No. 32 of 2011.

3.3 Calculation of Temporary Track Components: Sleeper Tension

Based on the technical data in Table 2, the bearing tension can be determined by performing the following calculations:

$$\mathrm{E} = 6400\sqrt{600}$$

Table 2. Dimensions of Temporary Track Concrete Sleeper

Item	Sleeper	
	Bottom Rail	Center Rail
Cross- Sectional Dimensions		
Large (A)	A1 = (150+250)/2 x 210 = 420 cm^2	A2 = (150+226)/2 x 190= 357 cm^2
Inertia (Ix)	$Ix_1 = 1/12.b.h^3 + 2\ (1/36.b.h)$ $= 1/12.15.21^3+2(1/36.5.21^3)$ $= 14148{,}75\ cm^4$	$Ix_2 = 1/12.b.h^3 + 2\ (1/36.b.h)$ $= 1/12.15.19^3+2(1/36.3{,}8.19^3)$ $= 10021{,}7611\ cm^4$
Ya (Upside Neutral line)	$21 - Y_{1\text{-}b} = 11{,}37$ cm	$21 - Y_{2\text{-}b} = 10{,}135$ cm
Yb (Downside Neutral line)	$Y_{1\text{-}b} = \frac{AI\frac{21}{3}+AII\frac{21}{2}+AIII\frac{21}{3}}{420\ Cm^2} = 9{,}625$ cm	$Y_{2\text{-}b} = \frac{AI\frac{21}{3}+AII\frac{21}{2}+AIII\frac{21}{3}}{357\ Cm^2} = 8{,}865$ cm
Wa (Upside Resistant Moment)	$W_{1a} = \frac{14148{,}75\ Cm4}{11{,}37\ Cm} = 1243{,}85\ cm^3$	$W_{2a} = \frac{10021{,}7611\ Cm\ 4}{10{,}135\ Cm} = 988{,}82\ cm^3$
Wb (Downside Resistant Moment)	$W_{1b} = \frac{14148{,}75\ Cm4}{9{,}625\ Cm} = 1470\ cm^3$	$W_{2b} = \frac{10021{,}7611\ Cm\ 4}{8{,}865\ Cm} = 1130{,}41\ cm^3$

$$E = 1{,}567673 \times 10^5\ \text{Kg/cm}^2$$

$$\gamma_r = \sqrt[4]{\frac{Kl}{4EIxl}} = \sqrt[4]{\frac{180}{4x1{,}56x10\hat{}5x14148{,}75}} = 0{,}012\ \text{cm}^{-1}$$

$$\gamma_r = \sqrt[4]{\frac{Kl}{4EIxl}} = \sqrt[4]{\frac{180}{4x1{,}56x10\hat{}5x10021{,}7611}} = 0{,}013\ \text{cm}^{-1}$$

$$Q = 60\%\ PD\ (PD = Ps[1 + 0{,}01\ (\frac{vplan}{1{,}069} - 5)] = 16771{,}86\ kg) = 60\%\ 16771{,}86 = 10063{,}12\ kg$$

$$Mcd = \frac{Q}{4\gamma}\ \frac{1}{\sin\gamma L + \sin\gamma L}[2\cosh^2\gamma a\ (\cos 2\gamma c + \cosh\gamma L) - 2\cos^2\gamma a\ (\cosh 2\gamma c + \cos\gamma L)$$

$$\sinh 2\gamma a(\sin 2\gamma c + \sinh\gamma L) - \sin 2\gamma a(\sinh 2\gamma c + \sin\gamma L)] = \frac{10063{,}12}{4(0{,}0122)} 0{,}482335 = 101120{,}8\ kgcm$$

$$Mo = \frac{Q}{2\gamma}\ \frac{1}{sin\,\gamma L + sinh\,\gamma L}[\sinh\gamma c(\sin\gamma c + \sin\gamma(L - c)) + \sin\gamma c(\sinh\gamma c + \sinh(L - c))$$

$$- \cosh\gamma c\ \cos\gamma(L - c) - \cos\gamma c\ \cosh(L - c)] = \frac{10063{,}12}{2\,0{,}013} \cdot 0{,}129341 = 50060{,}73\ kgcm$$

$$P_{initial} = \sigma \times A_{prestressed\ steel} = 15460\ \text{Kg/cm}^2 \times 3{,}14 \times 0{,}35\ \text{cm} \times 0{,}35\ \text{cm} = 5964{,}689\ \text{kg}$$

Based on Table 3, it can be seen that the tension on the concrete bearing appropriates the requirements based on the technical requirements in the Regulation of the Minister of Transportation No. 60 of 2012. That for the k-500 concrete bearing the compressive tension value is not more than 200 kg/cm^2.

3.4 Calculation of Temporary Track Components: Clip Fastener

The fastening clip used on the Temporary Track is in new condition. Based on the technical requirements in the Regulation of the Minister of Transportation No. 60 of

Table 3. Sleeper Tension Calculation Result

Item	Requirements	Results	Description
Initial Pretension Tension			
The upper side of the lower part of the rail (kg/cm^2)	<200 kg/cm^2	81,189 kg/cm^2	Appropriate
Lower side of the rail (kg/cm^2)	<200 kg/cm^2	81,786 kg/cm^2	Appropriate
Upper side of the center of the Sleeper (kg/cm^2)	<200 kg/cm^2	95,201 kg/cm^2	Appropriate
The lower side of the Center of the Sleeper (kg/cm^2)	<200 kg/cm^2	70,309 kg/cm^2	Appropriate
Effective Pretension Stage Tension			
The upper side of the lower part of the rail (kg/cm^2)	<200 kg/cm^2	123,50 kg/cm^2	Appropriate
Lower side of the rail (kg/cm^2)	<200 kg/cm^2	130,052 kg/cm^2	Appropriate
Upper side of the center of the Sleeper (kg/cm^2)	<200 kg/cm^2	23,642 kg/cm^2	Appropriate
Lower side of Sleeper Center (kg/cm^2)	<200 kg/cm^2	188,975 kg/cm^2	Appropriate

2012 that the Clip must appropriate the clamping force of 900–1100 kgf. Technical specifications of the clamping force on the Temporary Track at the joglo solo intersection produced by PT PINDAD with a clamping force of 1050 kgf (new product has not been damaged), so that it appropriates the requirements.

3.5 Calculation of Temporary Track Components: Ballast

The ballast profile check is carried out by measuring the ballast shoulder width and ballast leg width. The terms and conditions of the ballast profile width for Class II Road in accordance with the Minister of Transportation Regulation Number 60 of 2012 are 150 cm for the width of the ballast shoulder and 235 cm for the width of the ballast leg. Ballast profile measurements are carried out at 40 points every 5 m at KM 105 + 200-km 105 + 400. With the result that 32 points have met the requirements and 8 of them are not eligible, namely at KM 105 + 250 – KM 105 + 285. Thus, repairs and maintenance are needed in accordance with the Regulation of the Minister of Transportation No. 32 of 2011. Namely, the refinement of the ballast profile at KM 105 + 250 – KM 105 + 285 and matching with HTT So that the train journey can be guaranteed safety and comfort during the process of train construction joglo Solo elevated intersection.

From the calculation of ballast volume requirements, it is known that the total volume of gross ballast at the Joglo Solo Intersection Temporary Track is 214.02 m^3. In the Temporary Track Joglo Solo intersection, it is necessary to treat dirty ballast in the form of compaction with HTT and ballast washing in the amount of 214.02 m^3.

From the results of laboratory tests, it is known that the specific gravity test on the Temporary Track ballast sample complies with the technical specifications according to the Regulation of the Minister of Transportation No. 60 of 2012 which is 2.85 kg/cm^3 more than >2.6 kg/cm^3 for the specific gravity value; the porosity test on the Temporary Track ballast sample met the requirements, namely 0.65% met the requirements of <3% for the porosity value; the mud content test on the Temporary Track ballast sample met the requirements, namely 0.09% met the requirements, namely <0.5% for the mud content value; the Los Angeles test on the Temporary Track ballast sample met the requirements, namely 14.65% met the requirements, namely <25% for the aggregate wear value; The compressive strength test on the ballast sample does not appropriate the applicable specifications, which is less than 1000 kg/cm^2 for the ballast compressive strength value.

3.6 Evaluation of Requirements

Based on calculations and inspections of the rail, bearing, fastening and ballast components, it can be seen that several bearing and fastening components have met the requirements based on the Minister of Transportation Regulation No. 60 of 2012. Meanwhile, the rail components that do not appropriate the requirements are the base tension of the rails and a visual inspection of ballast between other things are dirty ballast, inappropriate profile shape, insufficient ballast profile, and ballast compressive strength test results that exceed the maximum average value of 1000 kg/cm^2.

3.7 Maintenance Cycle Recommendations

From the results of calculations and inspections on the Temporary Track of the Joglo Solo Intersection, it is known that there are still components that do not appropriate the requirements, namely the rail and ballast components. According to Rosyidi (2015) the large train load is one factor in the magnitude of the base tension value of the rail so that the potential damage that occurs is snake motion, bearing cracks, and loose fastenings. In addition, the results of the evaluation on the ballast have a compressive strength value exceeding the maximum provisions which have an impact on reducing the permeability properties of the ballast so that water does not flow easily and reducing the elasticity factor so that it affects the comfort of train travel; The shape of the profile that is not suitable causes the ballast to not bind to each other so that it has the potential to decrease in the ballast layer; and dirty ballast which can cause mud pumping.

The appropriate Treatment Cycle as a result of the impact in accordance with the Regulation of the Minister of Transportation Number 32 of 2012 is shown in Table 4.

Based on the Minister of Transportation Regulation No. 60 of 2012 the traffic is included in the category of rail road class II, so the maximum speed (S) of the traffic is 110 km/h. For the frequency of squeezing can be known by the calculation:

$$\text{Fp} = 0{,}166\% + 0{,}2075\% + 2{,}25\% + 0\% = 2{,}6235\% = 0{,}026$$

$$\text{F} = 0{,}023 \times \text{T}^{0{,}3} \times \text{v max} \times (1 + \text{fp}) = 0{,}023 \times 12{,}2^{0{,}3} \times 110^{0{,}5} \times (1 + 0{,}026) = 0{,}524 \text{ time/year}$$

Table 4. Maintenance Cycle Recommendations

Item	Tools	Frequency
Fastener System		
Fastening Fastener	Pen puller/hammer	7 Daily
Fastener Replacement	Pen puller/hammer	30 Daily
Rail Maintenance	Temperature measuring tool, Rail Profile toll, gauge, Ultrasonic	
Grinding, Straight		12 Monthly
Sleeper Maintenance		
Straighten up	Meter gauge, HTT, MTT, Jack tool	6 Monthly
Sleeper Adjusting		6 Monthly
Fastener Maintenance	Pen Puller/Hammer	3 Monthly
Ballast Maintenance		
Ballast tamping	water pass, Meter gauge, HTT, MTT, measuring cart, communication tool	6 Monthly
Ballast filling		6 Monthly

Based on the results of the calculation of the breaking frequency, it can be seen that based on the passing tonnage of the Temporary Track, it only needs to be pierced every 24 months. Meanwhile, based on the Regulation of the Minister of Transportation No. 32 of 2011 concerning standards and procedures for maintaining railway infrastructure, the frequency of breaking is every 6 months, which means that the Temporary Track of the Joglo Solo Intersection is in good condition. So that the Temporary Track does not need to be matched with MTT.

4 Conclusion

1. Based on the Regulation of the Minister of Transportation No. 60 of 2012 Temporary Track Joglo Solo Intersection is a class II railway line. With a passing tonnage of 12.2 million tons/year.
2. Based on the results of the evaluation and calculations, it can be seen that:

    a. Based on the calculation of the allowable tension on the Temporary Track, the requirements are Kg/cm^2 because 1325 kg/cm^2
    b. Based on the calculation of the base tension on the Temporary Track, it does not appropriate the requirements of 1141,896 kg/cm^2 because it is 1128 kg/cm^2.
    c. Based on the results of the tension calculation, the bearings used in the Temporary Track, namely the bearings produced by Wika Beton, appropriated the requirements.
    d. The specifications of the mooring equipment are in accordance with the technical requirements in the Regulation of the Minister of Transportation No. 60 of 2012

e. From the results of a visual inspection of the ballast components found components that not appropriate the requirements include dirty ballast, inappropriate ballast shape and poor ballast profile at KM 105 + 250 – KM 105 + 285.
f. From the results of laboratory tests on the ballast component of the ballast compressive strength test, it does not appropriate the requirements because it has a compressive strength value above 1000 kg/cm^2.

3. From the evaluation results, monthly maintenance on the Temporary Track is required in the form of grinding and alignment maintenance every 12 months on rail components, visual observation of bearings every 7 days and fastening maintenance in the form of tightening loose fasteners every 7 days and replacing missing fastenings every 30 days, matching with HTT as well as addition of less ballast components every 6 months and refinement of inappropriate ballast profiles every 6 months. In addition, based on the calculation of the breaking frequency, it can be seen that based on the passing tonnage, the matching cycle with MTT on the Temporary Track is 0.524 times/year, which means that the Joglo Solo Intersection Temporary Track is in good condition and does not need to be matched with MTT every month.

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