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ANALYSIS OF THE INFLUENCE OF RAIL LINE ON RAILWAY WHEEL FLENS WEAR

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ABSTRAK
Ministerial Regulation number 175 of 2015 about Technical Specification Normal Speed Trains with Self-Propelling, the hardness rate of the train wheels must be lower than the hardness of the rail road. Trains operating at speeds of are considered as normal speed trains. Based on field observations, generally the flange is wear faster. In cases where flanges are wear out, the wheel's flange must be to restored to its proper condition as long as the wheel diameter is still possible. This research was carried out by processing data using the Trend Linear and using the excel to get the results of a comparison of which wheels are faster to wear out on flange for each wheel in one train arrangement and which route causes wear out faster. Based on the data obtained, the Yogyakarta – Kutoarjo route traversed by An Electric-Diesel Locomotive Prambanan Express (Prameks) causes wear on flange than the Yogyakarta – Yogyakarta International Airport (YIA) route traversed by An Electric-Diesel Locomotive YIA and on the Solo – Wonogiri route traversed by An Electric-Diesel Locomotive Batara Kresna due to the total length of the mileage. and the longest total arc length of the two compared Lines. Meanwhile, the Solo – Wonogiri route traversed by An Electric-Diesel Locomotive Batara Kresna is ranked second in the cause of flange due to the smallest bend radius of the two compared lines. As well as the ranking of the last traffic that causes flange is the Yogyakarta - YIA.
Keywords: Flanges, An Electric-Diesel Locomotive, Line, An Electric-Diesel Locomotive Prameks, An Electric-Diesel Locomotive YIA, An Electric-Diesel Locomotive Batara Kresna

INTRODUCTION

Railway facilities operated in Indonesia are locomotives, trains, carriages, and special equipment (Suwardi et al., 2019). Every railroad facility that is operated is required to carry out maintenance on railroad facilities (Arief et al., 2022). Maintenance is carried out to maintain the reliability of the facility so that it remains operational and repairs are made to the damaged construction and components so that they can function again (Hasanah & Lo, 2020). Currently the Yogyakarta Locomotive Depot serves the maintenance of locomotives and propulsion facilities or Diesel Rail Train (KRD) .

One of the components of a train that runs on rails is the wheels (Naeimi et al., 2018). When the vehicle is running there will be friction between the rail head and the wheels, where this friction does not always occur in the same position because the wheels always move to the left or to the right due to a shift in the width of the rail track and the condition of the rail surface. According to PM number 175 of 2015 concerning Standard Technical Specifications for Normal Speed Trains with Self-Propulsion, the hardness of the wheels of a train must be lower than the hardness of the railroad tracks. This difference in hardness causes wheel wear to occur faster than wear on the railroad tracks along with the number of kilometers traveled by the train (Shi et al., 2018).

Wheel contact points indicate the part of the wheels that rub against the railroad tracks (Lewis et al., 2010). on a straight line, the dominant area 1 wheel makes contact with the rail (Sun et al., 2021). However, if you go through a bend, the area 2 wheel or the flange part will come into contact with the rail (Soleimani & Moavenian, 2017). According to (Dahlan & Syahminan, 2017), wear of the wheel flange due to excessive friction with the rail head will cause a decrease in reliability, increase maintenance costs and increase the possibility of derailment, therefore it is necessary to know the Line effect on flange wear to detect it early so that it didn't happen.

Based on the An Electric-Diesel Locomotive technical specifications, there is a maximum wear wheel diameter tolerance that is allowed to operate, which is 760 mm and a wear wheel flange tolerance, which is 8 mm (Pfaff & Pfaff, 2022). To maintain the reliability of the facility, it is necessary to handle a good maintenance process so that damage does not occur (Bal-Price & Coecke, 2011). The maintenance in question is preventive maintenance carried out at the Yogyakarta Locomotive Depot and at the Solo Locomotive Depot which are scheduled monthly, three months, six months and twelve months or one year.

Included in preventive maintenance is checking the wheels to find out whether the wheel diameter is still within tolerance limits (Asplund & Lin, 2016). Based on field observations, generally the wheel flange angle wears out faster (Magel & Kalousek, 2017). In cases where the flange is worn out, turning the wheel can be done to restore the wheel profile to its proper state (Muhamedsalih et al., 2019). But turning will result in a smaller wheel diameter than before (Foitzik et al., 2018).

METHOD

In the data collection method, the process of collecting primary data and secondary data is carried out. Primary data is used to analyze wheel flange wear to complete the research data. The primary data collection technique is carried out by the observation method which is carried out by observing directly, seeing, and taking the required data. Secondary data was obtained from data belonging to the Indonesian Railways regional operations and regional divisions (DAOP) VI-Yogyakarta Bridge Road office and Yogyakarta Locomotive Depot. After collecting data, data processing is carried out. In this study, the data was processed by means of analysis using the Linear Trend method using the Excel application to obtain Line-comparison results where wheel flange wear was more dominant between the three trains with different tracks.

The final stage after processing the data is analyzing the data to find out the results of the research that has been done by determining the conclusions of the analysis process that has been done. After carrying out the data processing stages by using the Linear Trend method in the next excel application, analyze the results which consist of the value of the increase in wear that will occur on the wheel flange of An Electric-Diesel Locomotive YIA, Prameks and Batara Kresna to obtain forecasting data that has been carried out.

RESULTS AND DISCUSSION

Amount of Curvature Comparison

After carrying out an analysis of wheel flange wear, then perform an analysis of accumulated total bend every month for 6 months for An Electric-Diesel Locomotive YIA and Batara Kresna and for 8 months for An Electric-Diesel Locomotive Prameks with the following results:

Table-4. Comparison of the Number of Arches 1 Trip

No.	Line	Small	Medium	Large
1	An Electric-Diesel Locomotive Yia	12 (6,997 Meters)	35 (13,132.37 Meters)	20 (2,125.26 Meters)
2	An Electric-Diesel Locomotive Prameks	12 (6,744 Meters)	46 (13,530.37 Meters)	28 (2,537 Meters)
3	An Electric-Diesel Locomotive Batara Kresna	13 (5,696 Meters)	19 (8,840 Meters)	2 (1,246 Meters)

The percentages from the table above can be seen in the table below:

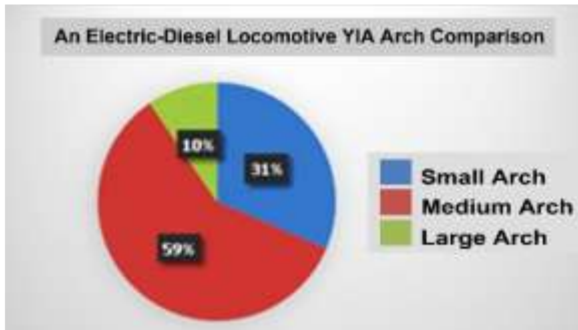

Figure-10. An Electric-Diesel Locomotive YIA Arch Comparison Diagram

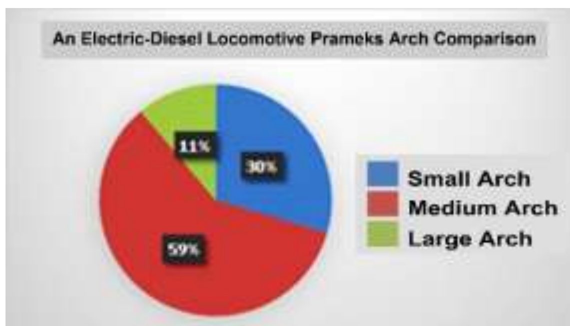

Figure-11. An Electric-Diesel Locomotive Prameks Arch Comparison Diagram

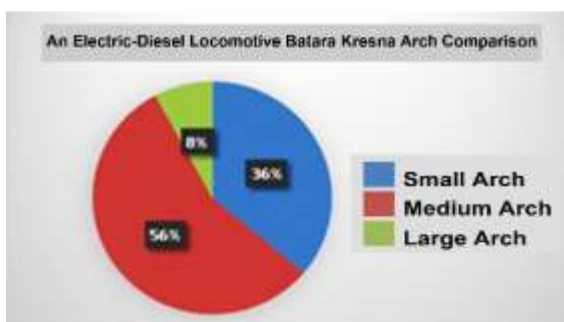

Figure-12. An Electric-Diesel Locomotive Batara Kresna Arch Comparison Diagram

Based on the results of the analysis of the number of curves on the three types of trains with different lines, there is a moderate percentage of curves between An Electric-Diesel Locomotive YIA and Prameks of 59%, and An Electric-Diesel Locomotive YIA has 1% more small curves than Prameks from the total accumulation of curves overall on the An Electric-Diesel Locomotive YIA and Prameks. Whereas in Batara Kresna there are 56% for medium arches, 8% for large arches and 36% for small arches where the percentage of medium and large arches is smaller and the percentage of small arches is greater than the An Electric-Diesel Locomotive YIA and Prameks routes.

Curvature Relationship with Wear

After obtaining wheel flange wear data and arch accumulation data for 6 months, then linking wheel flange wear and arch accumulation to be able to find changes/addition to wheel flange wear every 1 millimeter, so it takes a total of how many kilometers/round trip (PP) to wear the wheel flange reaches its maximum wear value (8 mm).

The total wear of the An Electric-Diesel Locomotive YIA wheel flange A plate is as follows:

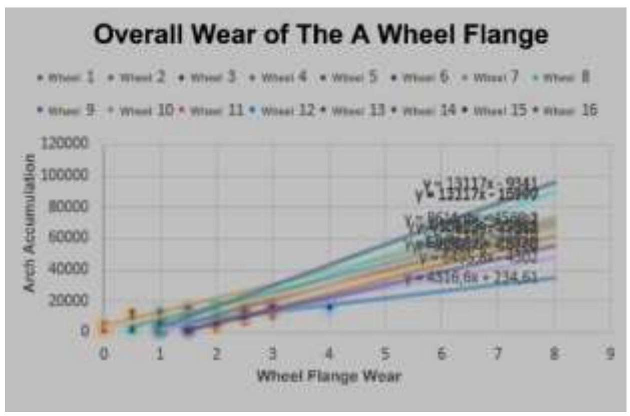

Figure-13. Total Wear of An Electric-Diesel Locomotive YIA Wheel Flange A piece

The total wear of the An Electric-Diesel Locomotive YIA wheel flange B is as follows:

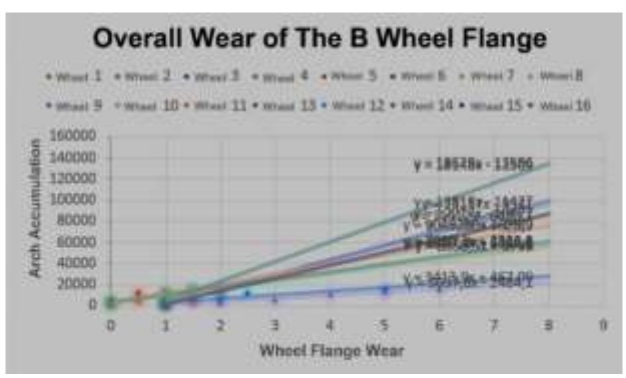

Figure-14. An Electric-Diesel Locomotive YIA Plate B Total Flange Wear.

The arch relationship with wear and tear on each track is presented in the following tables:

Table-5. An Electric-Diesel Locomotive YIA Wheel Flange Wear

Flange	Average	Trip	Fastest	Longest
A	9,407.06875 km	410 trip	188 trip	572 trip
B	10,126.33125 km	442 trip	149 trip	813 trip

So the average distance of additional wheel flange wear per millimeter on An Electric-Diesel Locomotive YIA on plate A is 9,407.07 km or 410 trips and on plate B is 10,126.33 km or 442 trips. For wheels that wear out the wheel flange the fastest, there are wheels 6 for plates A 188 trips and B 149 trips, for wheels that experience wear on the wheel flange for a long time, there are wheels 16 for plates A 572 trips and B 813 trips.

The total wear of the Prameks train wheel flange A is as follows:

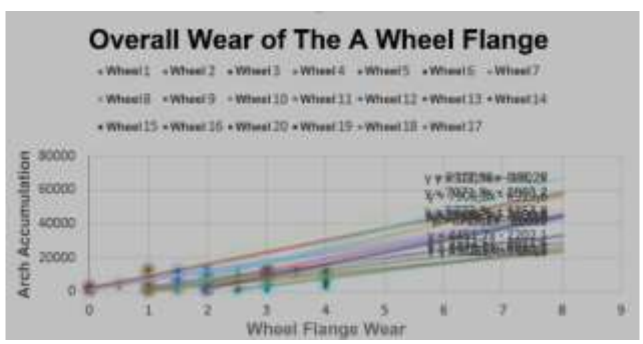

Figure-15. Total Wear of Prameks Wheel Flange A

The total wear of the Prameks KA wheel flange B is as follows:

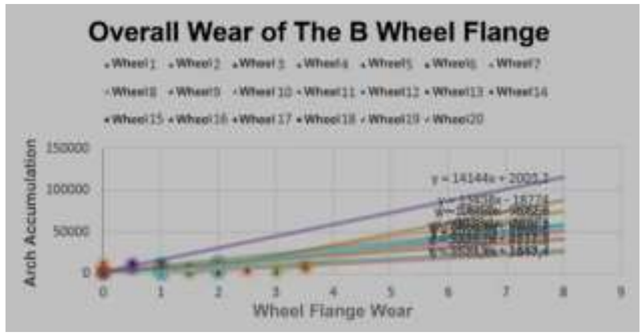

Figure-16. Total Wear of Prameks Wheel Flange B.

Table-6. An Electric-Diesel Locomotive Prameks Wheel Flange Wear

Flange	Average	Trip	Fastest	Longest
A	5,775.025 km	220 trip	102 trip	277 trip
B	7,648.928571 km	291 trip	109 trip	440 trip

So the average distance of additional wheel flange wear per millimeter on An Electric-Diesel Locomotive YIA on plate A is 5,775.03 km or 220 trips and on plate B is 7,648.92 km or 291 trips. For wheels that wear the wheel flange the fastest, there are wheel 13 for plate A with 102 trips and wheel 5 for plate B, there are 109 trips. 15 for chip B as much as 440 trips.

The total wear of the An Electric-Diesel Locomotive Batara Kresna wheel flange A is as follows:

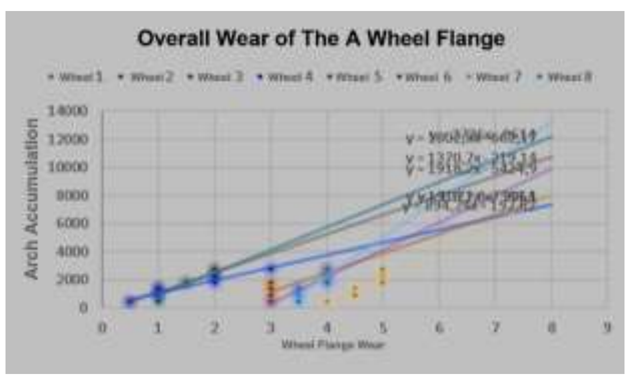

Figure-17. Total wear of An Electric-Diesel Locomotive Batara Kresna Chip A wheel flange

The total wear of the wheel flange of An Electric-Diesel Locomotive Batara Kresna chip B is as follows:

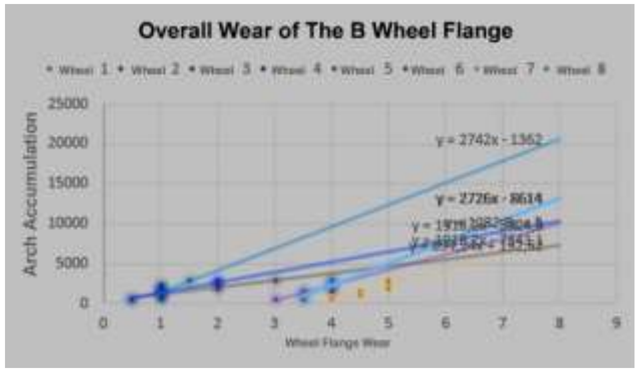

Figure-18. Total Wear of An Electric-Diesel Locomotive Batara Kresna Chip B Wheel Flange.

Table-7. AN ELECTRIC-DIESEL LOCOMOTIVE Batara Kresna Wheel Flange Wear

Flange	Average	Trip	Fastest	Longest
A	3,120.0625 km	197 trip	117 trip	251 trip
B	4,046.725 km	256 trip	117 trip	361 trip

So the average distance of additional wheel flange wear per millimeter on An Electric-Diesel Locomotive YIA on plate A is 3,120.0625 km or 197 trips and on plate B is 4,046.725 km or 256 trips.For wheels that wear the wheel flange the fastest, there are wheel 4 for plate A with 117 trips and wheel 3 for plate B, there are 117 trips. 5 for chip B as many as 361 trips

Mileage Relationship With Wear

After obtaining the track data which includes the total curved path and the total straight path as well as the fastest wheel flange wear data on each type of train according to the path it is traversing, then a comparison is made between the curved path and the straight path on the wear that occurs on the An Electric-Diesel Locomotive wheel flange to obtain a conclusion on which path the more dominant is wear and tear on the wheel flanges according to the path taken by An Electric-Diesel Locomotive YIA, Prameks and Batara Kresna.

Based on the data obtained, on the Yogyakarta – Kutoarjo Line which is traversed by the Prameks An Electric-Diesel Locomotive tends to experience wear on the wheel flanges faster than the Yogyakarta – YIA Line which is traversed by the YIA An Electric-Diesel Locomotive and on the Solo – Wonogiri Line which is traversed by the Batara Kresna An Electric-Diesel Locomotive due to the total length of the distance The distance traveled and the total length of the curve on the Prameks An Electric-Diesel Locomotive is longer than the paths traversed by the An Electric-Diesel Locomotive YIA and the an electric-diesel locomotive Batara Kresna. Whereas on the Solo - Wonogiri route it causes faster wheel flange wear than on the Yogyakarta - YIA route due to the smaller bend radius and the greater number of small curves

Table-8. Smallest Radius Comparison Table with Wheel Flange Wear

Train name	Track (km)	Curved Path (km)	Straight Path (km)	Total Small Arch (Arch)	Smallest Radius Of Small Arch (m)	Wear and tear Chip A (Trip)	Chip B (Trip)
An Electric-Diesel Locomotive YIA	(Yogyakarta – YIA) 80	22.9	5.1	12	397	188	149
An Electric-Diesel Locomotive Prameks	(Yogyakarta – Kutoarjo) 128	26.2	101.8	12	135	102	109
An Electric-Diesel Locomotive Batara Kresna	(Solo – Wonogiri) 75.2	15.8	59.4	13	397	117	117

CONCLUSION

From the results of design, manufacture and testing has been done, it can be concluded as follows: Temperature and humidity sensors (DHT22) are able to read the temperature value with a percent error of 1.3% on sensor 1 and sensor 2. Temperature and humidity sensors (DHT22) were able to read the humidity value with a percent error of 2.4% in sensors 1 and 2.6% in sensor 2. Chips have a moisture content of 51.9% when dried with conventional power (solar heat), whereas when using a dryer the amount of moisture content in chips is 51-54%. Dryer capable of drying chips without damaging the morphology of the chips themselves (not congealed). The drying duration carried out by the dryer is only 70 minutes. Much faster when compared with using conventional power (solar heat) that is for 8 hours. 3Kg LPG fuel can be used up to 3x drying process. The system power consumption at standby is 10 watts. At the time of lighter ON of 126 watts. At the time of the blower ON, the required power is 71.5 watts.

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