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Experimental Analysis and Improvements in Heat Generation Due to Friction in Rail Wheels

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Abstract - Indian Railways has one of the world's largest rail networks with over 100,000 track kilometers. It operates over 20,000 trains daily with over 9,500 locomotives, 46,000 coaches and 240,000 wagons. However, from 2004 onwards, when majority of the cast iron brake blocks were replaced with composite brake blocks, there have been hundreds of incidences of gauge widening in locomotive wheels. This work aims to identify root cause of failures and prevent occurrence of same in future. To this end, the following work is carried out in this thesis:
1- Development of a train running model to estimate heat generated at brake pad-wheel and rail-wheel interfaces for locomotive and wagon wheels using brake block characteristics, wheel-rail traction slip characteristics and train running resistance characteristics.
2- Investigation of the effect of wheel profile, brake block type, and braking conditions on locomotive wheel failure from gauge widening and condemning.
3- Identification of the underlying mechanism of locomotive wheel failure from gauge widening and condemning.

Key Words: Brake blocks, locomotive wheels, pad-wheel, Resistance, wheel profile, gauge widening, condemning.

1.Introduction

Railways were first introduced to India in 1853 from Bombay to Thane. A British engineer, Robert Brereton, was responsible for the expansion of the railways from 1857 onwards. Indian Railways has one of the world's largest rail networks with over 100,000 track kilometers. It operates over 20,000 trains daily with over 10,000 locomotives, 46,000 coaches and 240,000 wagons. This analysis aims to identify root cause of failures and accidents occurs in Indian Railways and to prevent them in future. This project is the investigation carried out for various alternative materials which can be used by replacing the normal ongoing materials

2. Literature Survey

1. Mithun Sharma - "Analysis of Causes of Major Train Derailment and Their Effect on Accident Rates"

Statistical analyses were conducted to examine the effects of accident cause, type of track, and derailment speed. The analysis showed that broken rails or welds were the leading derailment cause on main, yard, and siding tracks. By contrast to accident causes on main tracks, bearing failures and broken wheels were not among the top accident causes on yard or siding tracks. In general, at derailment speeds below 10 mph, certain track and human factor causes such as improper train handling, braking operations, and improper use of switches dominated. At derailment speeds above 25 mph, those causes were nearly absent and were replaced by equipment causes, Analysis of Causes of accident:-We have analyze the various causes of accident in Indian railway and collected data and from that we have found that the major of accident is due to derailment.

Current material used in Railway wheels:-The current material use in Indian railway is cast wheel (R-19/1993) Part3.

Factor affecting performance of wheel:-Factor affecting performance of wheel is yield strength, elongation, tensile stress, hardness, impact load.

Investigation of various alternative material:-We have investigated 13 various alternative material.
such as bearing failure, broken wheel, and axle and journal defects.

2. Muhammad Ragil - "Preliminary study for modeling train accident in India using Swiss Cheese Model"
It is necessary to put more attention in finding a solution to prevent the accident by identifying the root causes of the accident using accident model. Swiss Cheese Model, one of the basic models of accident, acts as a framework for accident investigation. Based on this train accident, there are four factors that should be considered for understanding the accident: maintenance system, shift system, crossing system between rail and other road vehicles, and warning system.

3. Dimitrios Nikas - "Effect of Temperature on Mechanical Properties of Railway Wheel Steels"
One of the most important aspects in railway operation is the interaction between rail and wheel. Medium carbon steels are used in these components due to their combination of high strength and good wear properties in relation to cost. Long-term block braking may heat the wheel rim to over 500°C. It is thus relevant to examine the high temperature performance of wheel material as well as the decrease in strength after thermal exposure.

4. Sathish Gandhi - "Performance Analysis of Wheel and Rail Contact by Nature of Material Characteristics"
Contact analysis can be traced back to 1882, in which Hertz studied the elastic contact between two glass lenses.
The Hertz theory is restricted to the normal frictionless contact between an elastic half–space with small deformation.

3. Objective of Research

- To reduce the accident in Indian railway due to derailment.
- Provide the safe journey to passenger.
- To increase the life of wheel.
- Changes in railway wheel material to reduce accident and reduce the maintenance of the wheel.
- Reduce the cost of the wheel.

4. Methodology

Analysis of Causes of accident: -We have analyzed the various causes of accident in Indian railway and collected data and from that we have found that the major of accident is due to derailment.

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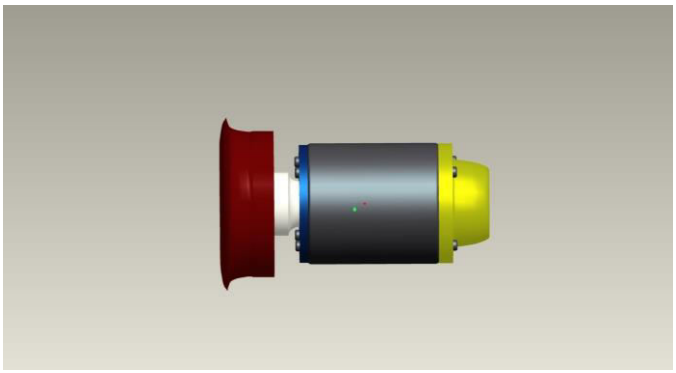
Investigation of various alternative material: -We have investigated 13 various alternative material.

Selection of optimum material: - We have selected 5 material out of 13 alternative material by survey and we have found the score of criteria by numerical method.

Comparison of selected material with existing material: - we have compared all 5 material by Promethee method manually and by visual Promethee software version 1.4.0.0.

CAD image of Axle box assembly



5.Investigation of Alternate Materials

1. MATERIAL NAME: - ER6
   Standard / Country :- Romania / ASRO
   Subgroup :- SR EN 13262 (2008)

2. MATERIAL NAME: - 50Cr4V2
   Standard / Country :- India / IS
   Subgroup :-IS 3930 (1994)

3. MATERIAL NAME: - P45A
   Standard / Country :- Poland / PN
   Subgroup :- PN-H-84027-1 (1994)

4. Material name :- ER8
   Standard / Country: - Hungary / MSZ
   Subgroup :- MSZ EN 13262 (2008)

5. Material name : - Grade 2 (GOST 10791)
   Standard / Country: - Russia / GOST
   Subgroup :- GOST 10791 (2011)

6. Material name :- M76
   Standard / Country :- Russia / GOST
   Subgroup :- GOST R 51685 (2000)

7. Material Name :- 20 MnV5
   Standard / Count :-Italy / UNI
   Subgroup :-UNI 7176 (1973)

8. Material Name :- C74GW-N-A
   Standard / Country :- Japan / JIS
   Subgroup :- E 5402-1 (2005)

9. Material Name :- C51GW-T-A
   Standard / Country :- International / ISO
   Subgroup :- ISO 1005-6 (1994)

10. Material Nam :- EN 13261
    Standard / Country :- France / AFNOR NF
    Subgroup :- NF EN 13261 (2010)

6. Conclusion

From this software it concluded that M76 is best alternative material to replace the existing R-19 material which show the score of -0.600 while M76 is 0.60.

From Promethee Gaina software Promethee flow table show that ϕ 0.4793 value for M76 and 0.1399, 0.1391, -0.2537, 0.5546 for ER-9, ER-8, ER-7, AND ER-6 respectively.

To avoiding the derailment accident in railway we concluded that wheel should be made up of M76 material is best among all selected material. We also compare this material with existing material and analysis show that the M76 is better option for us to replace the existing material.

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