THE INVESTIGATION OF DERAILMENTS IN INDIAN RAILWAYS

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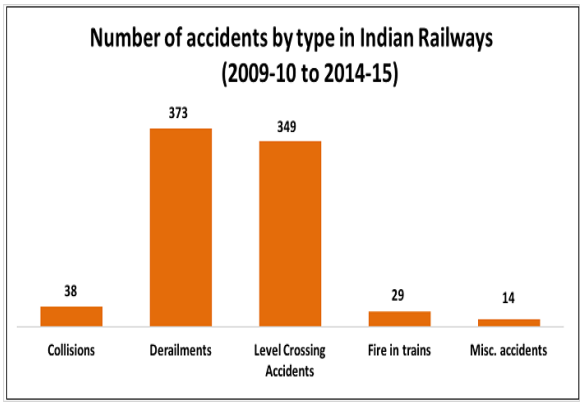
Abstract

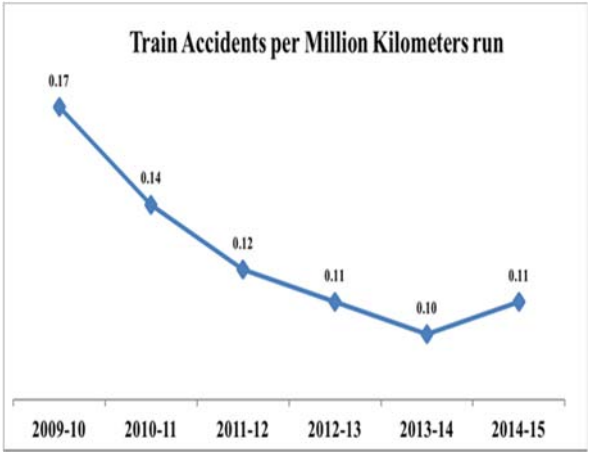
A derailment is said to take place when a vehicle such as a train runs off its rails. This does not necessarily mean that it leaves its track . In a emergency situations, deliberate derailment with derails or catch points is sometimes used to prevent a more serious accident. The present works attempt to prevent and minimize the derailment for which identification of rolling stock particulars and defects, derailment mechanism, sound theoretical understanding of the whole phenomenon of vehicle track interaction is studied that helps one to analyze the evidence logically and systematically and to arrive at the probable causes of derailment.

Key words: Rolling stock, derailment mechanism, causes of derailment.

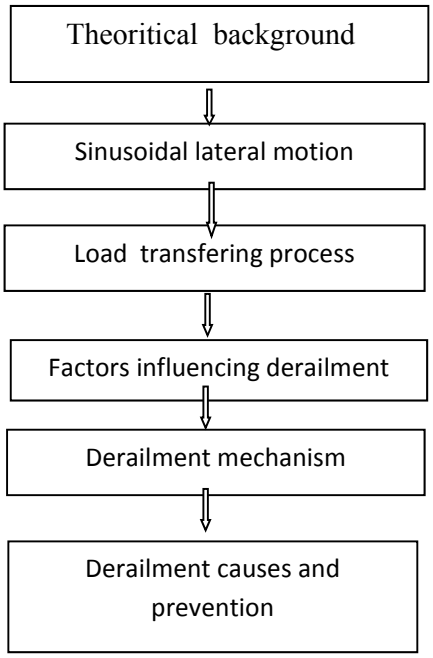
1. INTRODUCTION

Railway is the major mode of transportation next to the roadway for the public. It facilitates large scale production by increasing mobility of raw materials, workers, consumption of heavy, bulky and perishable commodities by cheap and speedy transportation. It is primary transportation connecting even small villages. Apart from these though Indian Railways has come a long way any failure in operation system will lead to loss of human life, valuable properties of railways, discomfort of passengers. It is essential to identify the reasons for such incidents which may arise during railway services. Statistics show that 76 percent of the rail accidents take place because of derailments following human error, track problems or adverse weather conditions.

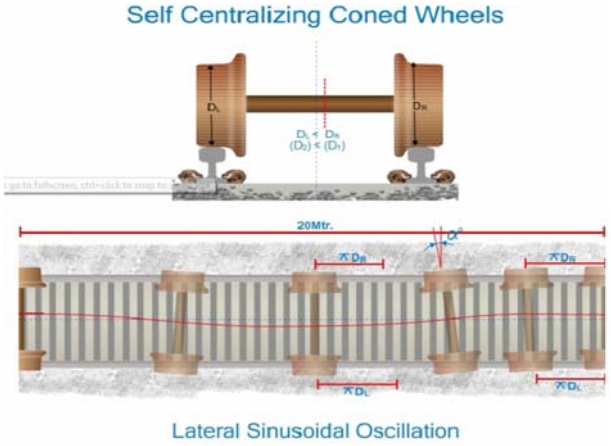




2. METHODOLOGY:



3. SINUSOIDAL LATERAL MOTION



3.1.SINUSOIDAL MOTION :

$\lambda = V \times T$

λ = Wave length

V= linear speed

T= period of oscillation

Linear speed , $V = a \times \omega$

Angular speed , $\omega = 2\pi / T$

$\omega = 2 \pi V / \lambda$

Amplitude (a) = $\sigma / 2$ = play / 2

4. DERAILMENT MECHANISM

Two broad categories:

- Sudden Derailment:
  - By wheel set jumping the rail.
  - Indicates that derailing forces are high enough to suddenly force wheel off the rail.
- Derailment by flange climbing:
  - By wheel mounting the rail in a relatively gradual manner.
  - Indicates that derailing forces are powerful enough to overcome normal stabilizing forces yet not sufficient to cause sudden derailment.

Arriving at probable cause in case of sudden derailment is easier. Not much theoretical analysis required.

Comparatively difficult to establish cause in case of derailment by flange climbing, deeper theoretical understanding/analysis required.

4.1. CAUSES OF DERAILMENT

Few major causes of derailment includes :

- Track defects
- Defective wheel
- Flange climbing

5. ULTRA SONIC TEST – TRACK DEFECTS

5.1.ULTRA SONIC WAVES :

- These are nothing but sound waves, having very high frequency range, which are beyond the audible range of Human ears.
- Sonic waves : 20 - 20,000 cycles/ sec (Audible)
- Sub–sonic waves :< 20 cycles/ sec (Below Audible)
- Ultra–sonic waves:> 20,000 cycles/ sec (Beyond Audible)

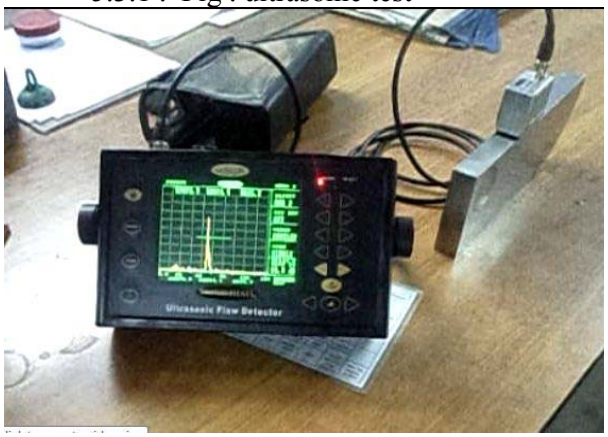
5.2.GENERATION OF US WAVES

- Crystals are used for the generation of Ultrasonic waves
- The crystals are called PIEZO-ELECTRIC MATERIALS
- Piezo – electric effect is that vibrations are created in the materials by alternating passage of electric potential at the faces of the material, or vice- versa

5.3.PRINCIPLE :

- The rebound sound from a striking hammer is an Ultrasonic sound
- In UST ultrasonic waves are sent through a testing specimen.
- The time between the transmission and reception of these waves is taken as the base for detecting the flaws.

5.3.1 . Fig . ultrasonic test



5.3.2. Fig . graph showing test results

5.4.ULTRASONIC INSPECTION (PULSE-ECHO)

- High frequency sound waves are introduced into a material and they are reflected back from surfaces or flaws.
- Reflected sound energy is displayed versus time, and inspector can visualize a cross section of the specimen showing the depth of features that reflect sound.
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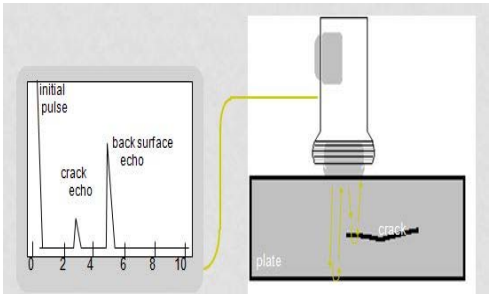


6. WORN WHEEL PROFILE :

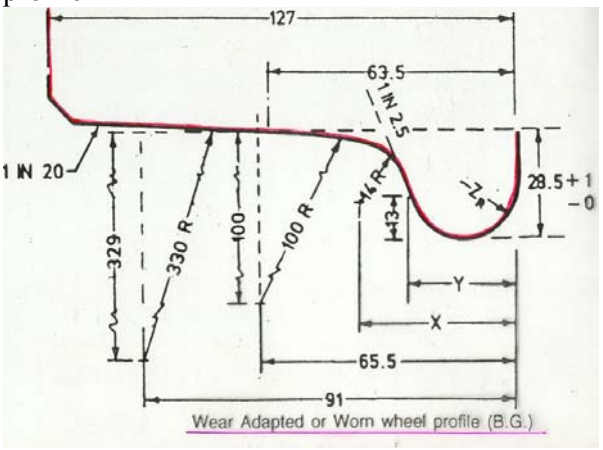
Defective wheels can be identified using a device called as wheel profile gauge.If there is any defects in the wheel it is rectified in the lathe.

Fig . 6.1. wheel profile gauge

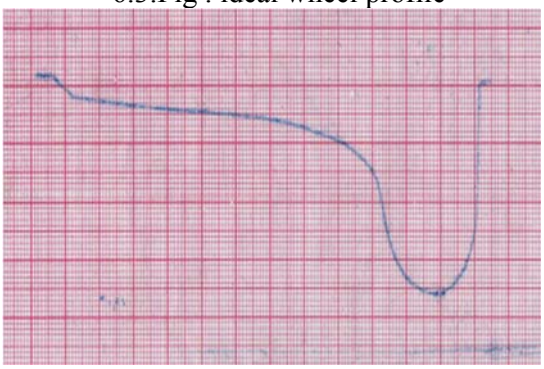
TABLE – INTERMEDIATE WORN WHEEL PROFILE

Thickness of Flange (mm)	D1 (mm)	D2 (mm)	D3 (mm)	R1 (mm)	R2 (mm)	R3 (mm)	R4 (mm)
25	38.5	65.5	91	11.5	14	100	330
22	35.5	65.5	91	10	14	100	330
20	33.5	65.5	91	9	14	100	330

Table .6.2. Intermediate worn wheel profile



6.3.Fig . ideal wheel profile



6.4.Fig . worn wheel profile graph

6.1.BENEFITS OF WORN WHEEL PROFILE :

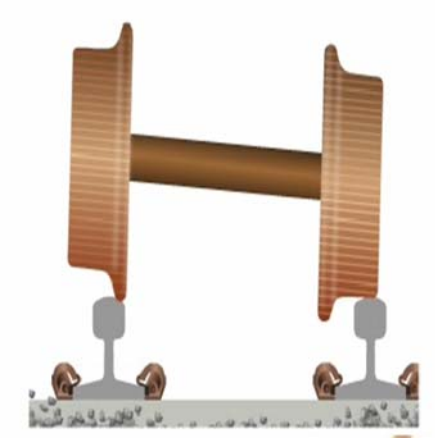
- It increases the life of wheel
- It decreases machining cost

- Less fuel consumption of the engine
- It increases the wheel lateral oscillation

7. FLANGE CLIMBING DERAILMENT

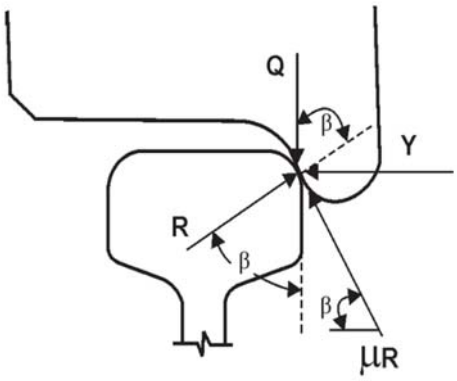
- Under the influence of distributing lateral forces or due to angular movement of wheel set with respect to the track as in curves the wheel flange comes in contact with rail gauge face, under this condition lateral flange force (y) is generated

- If the magnitude of lateral force is beyond the limit, wheel flange may start moving up along the rail gauge. This phenomenon is called as wheel mounting and the point at which the wheel starts moving is termed as Point of Mounting



7.1 .Fig flange climbing

- Due to sliding movement of wheel tread of non-derailing wheel on rail surface, friction force is generated which acts in same direction as that of Y , thus increasing derailing forces.
- Q has to be increased for ensuring safety.
- For ensuring safety, not only that derailment coefficient Y/Q should exceed limiting value but Q itself should not drop below certain min value.



Resolving the forces ,
Assuming the track is rigid ,
Reaction force R acting,

$$R = Q \cos \beta + Y \sin \beta$$

Due to the tendency of downward movement of the wheel flange.
A frictional force = μ R is generated
Consider the resultant of the forces acting on the wheel along flange slope.

i. Resultant force downward along slope

$$\mu R + Y \sin \beta - Q \sin \beta < 0$$

downward movement – safer

ii. resultant force upward along wheel slope

$$\mu R + Y \sin \beta - Q \sin \beta > 0$$

upward movement along slope

If this condition is maintained for sufficiently long time the wheel flange will climb on to rail top, finally resulting in derailment

8. CONCLUSION

Derailment leads to loss of life and property in worst situations.The reasons of derailment can be due to defects in permanent way and wagons, operating features, signal failure, material failures and apart from these human failure plays the main role .In order to minimize derailment, wheel –track interaction should be maintained properly which is the work of civil engineerinrs partly.In our study we arrived the causes of derailment from past accidents and concluded with the test procedure and preventive measures to avoid and minimize the derailment which will ultimately minimizes the future accidents.

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