IMPROVED MAINTENANCE PRACTICES IN CONTEXT OF HEAVY AXLE LOAD
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Synopsis :-
Railway Track is normally under heavy traffic due to movement of goods traffic and passenger's traffic. Since railway track bear heavy dynamic load and vibrations, hence require continuous monitoring and regular maintenance. Due to introduction of heavy axle load maintenance efforts will be increased, hence maintenance practices required improvement so that the effect of heavy axle load can be sustained. An attempt has been made in this paper to utilize improvement maintenance practices under heavy axle load for better maintenance of railway track.

1. Introduction :-
Earlier in Indian Railways the maximum axle load was 22.5 Tonne where as actually the axle load was only 16 Tonne. Now due to introduction of CC+8+2 the load increase up to 22.8 Tonne & for dedicated freight corridor the planning is being done for 25 Tonne to 32.5 Tonne . Therefore it is need of the time that the maintenance practices to be improved, so that the effect of heavy axle load can be taken care of and the life and reliability of track structure can be improved.

2.Factors effecting rail life :-
Rail Life is restricted due to excessive wear and large defects due to fatigue. There is a trade-off between wear and fatigue. We can make optimum use of the rail by controlling either wear or fatigue related defects, as the case may be Vertical Loads – increased manifold due to heavy loads

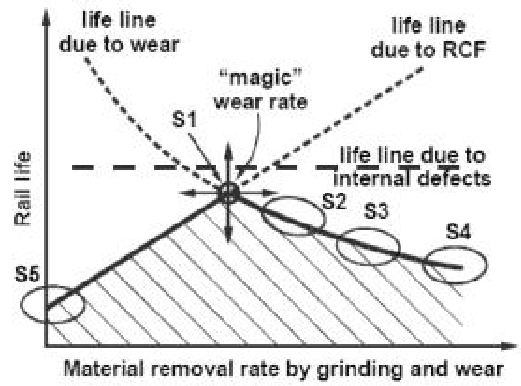
- Dynamic Augmentation due to effect of track geometry imperfections and rail or wheel surface defects – can increase the vertical loads 2 to 4 times
- Lateral Loads –
  - Due to sinusoidal movement of wheel on the straight track
  - On a curve, the lateral forces are much more pronounced
- Longitudinal Loads –
  - Tractive and Braking forces
  - Thermal forces due to temp variations

3. Improved maintenance practices:-

1.Rail Grinding
Rail Grinding is an important track maintenance tool .Rail Grinding is the removal of metal from the surface of the rail head through the action of a rotating grinding wheel
Mechanism used in rail grinding is cutting of metal associated with formation of metal chips (and not metal deformation) .Grinding eliminates rail corrugation while re-profiling it simultaneously, thus reducing the crack distribution process and wear:
• it unloads the crack mouth: their growth is no longer possible and fluid can not be trapped anymore;
• through rail re-profiling, the wheel-rail contact spot is moved to the top of the rail; the gauge corner is not subjected anymore to fatigue;
• it reduces flange wear on the outer rail, improving train stability and as a result of all this, it also reduces the amount of rail-wheel contact points and rolling noise.
The grinding type (initial, systematic preventive and corrective) and the intervals are set up according to the potential degree of exposure, the extent and the gravity of the defects (figure 10). Concerning tolerances, it is essential to determine the acceptable tolerances, in particular according to rail profile type of and its steel. In some rail sections such as switches or

expansion joints this operation can be very delicate – in some countries grinding is therefore prohibited in these situations.

Figure 10 - Grinding strategies according rail cycle life



strategy S1 : initial preventive; strategy S2 : preventive systematic; strategy S3 : maintenance; strategy S4 : corrective; strategy S5 : no grinding

strategy S1 : initial preventive; strategy S2 : preventive systematic; strategy S3 : maintenance; strategy S4 :
corrective; strategy S5 : no grinding Rail systems ranging from Mass Transit to High Speed to Heavy Haul require different grinding approaches. Each must consider distribution of curvature, variety/complexity of rolling stock, available track time and grinding equipment and the extent of lubrication and top of rail friction management (if any) in the system. Priorities of the railway management with respect to gauge-face / wheel-flange wear, vehicle dynamic (hunting) performance, corrugations or RCF wheel shelling (where applicable) and rolling contact fatigue must also be factored in. In some systems, grinding to a set of rail profiles that is matched by "worn" wheel profile can balance the conflicting requirements of all four priorities. In other systems, many heavy haul lines for example, the conflicting requirements of gauge face wear and RCF cannot be satisfied. Wear must be controlled by reliable lubrication, and RCF through an appropriate grinding strategy.

•Strategy S1 in Figure 10 is the condition where rolling contact fatigue is controlled by sufficient and frequent material removal by grinding and complementary wear, i.e. the magic wear rate. Experience with preventive grinding shows that this value is about 0.002-0.003" from the top-of-rail and about 0.006" from gauge-corner of high-rail and field-side of low-rail every 15-30 MGT. After the single, high-speed (e.g. 8-10 mph) grinding pass, a clean and properly profiled rail surface is left behind.Since only a small amount of material is removed the remaining surface, already work hardened with favorable compressive residual stresses, inhibits further deformation and crack initiation. Sharp curves are ground more frequently than mild curves, with tangent rail ground least often. This strategy is suitable for a newly installed rail ground to correct profiles or rail that has been recovered by S2–S4.

•S2 represents the preventive-gradual process [17]. By slowing down the machine, increasing the grinding motor amperage, optimizing the rail grinding patterns and decreasing the grinding interval, the amount of metal removed each cycle can be increased. This strategy is applied to "catch-up" on rail that has existing cracks or poor profiles. Usually a preventive grinding

interval of 15-20 MGT is used. Once the rail surface has been cleaned of RCF damage and restored to the desired set of profiles,
S1 should be the target.

•S3 is a maintenance grinding practice with longer grinding intervals and more metal removed each time using slow, multiple passes (usually 2 or 3) on some curves. Rail that is single-passed is usually treated at slow speeds (e.g. 4-6 mph). Although this strategy prevents heavy RCF damage, it shortens the life of rail.

•S4 is the case of corrective grinding where rail is usually in an advanced state of RCF damage. Grinding frequency is based on other factors or limitations rather than MGT and is typically much longer than in S1 – S3. Only track with obvious RCF is treated, track without visible damage is not ground. A large quantity of metal is ground off the head of the rail. This is accomplished by many low-speed passes (say 3-7) especially in curves. Removal of the work hardened layer leads to high initial rates of plastic flow, rapid deterioration of rail profiles and accelerated growth of RCF damage that further curtails rail life.

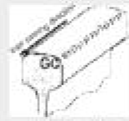
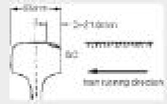
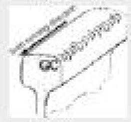
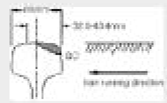
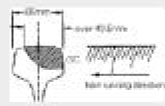
• S5 represents the no-grind philosophy. The only wear occurs from the wheel-rail contact. The rail eventually fails, sometime very quickly, due to rolling contact fatigue. Premium steels in curves and dry environments have successfully withstood several hundred MGT without grinding but the end life was still a fraction of what could be achieved with regular maintenance.

Grinding is a powerful tool for preventing significant RCF development (and removing existing surface RCF) and thereby enhances the safety and economy of railway operations. In addition to removing cracks and the fatigued layer from the surface of the rail it can regularly maintain the optimal rail profiles. Optimal profiles minimize normal contact stresses and reduce shear stresses in the rail by controlling longitudinal, and to some extent, lateral traction forces between wheel and rail. Another important duty of
optimal profiles is to spread wear on the wheel tread and reduce wheel hollowing.

Unfortunately, there is no one ideal grinding interval, magic wear rate or set of optimal rail shapes. They can only be determined after first evaluating the features and priorities of the target system. Based on analysis and measurements of worn wheel and rail profiles of a railway line, the shape of optimal rail profiles can be determined. Before application to the entire system, those profiles should be validated in monitored test sites, together with lubrication and metallurgy that is typical for the system. These test sites also provide a unique opportunity to fine-tune the grinding strategy with respect to metal removal rates and grinding intervals that are consistent with MWR for effective control of RCF damage. Monitoring can also be adjusted to include any other priorities of railway management such as gauge face wear, hunting of vehicles, top of rail friction management, corrugations and so on.

For head checks, grinding intervention must be done as soon as possible after track laying to avoid the development of head checks. If cracks are visible, it is generally too late to solve it by grinding totally and in an economic way. When cracks exceed 15mm of length, it is necessary to remove the rail or the switch component.

Figure 11 - Cracks classification and propagation and tasks to undertake

Contents	Appearance	Inside	Action
Head check can be found at gauge corner			Recording
Head check propagate on the other corner of rail head			Marking
Head check propagate up to thirds of the breadth of rail head			Installing fish plates and scheduling replacement
A crack of head check propagates more and comes to be transverse fissure			Replacing as soon as possible

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Each Grinding wheel is attached to an individual grinding motor rotating it at about 3600 rpm

Grinding Wheel – Outer dia – 250 mm

- Inner dia - 150 mm
- Thickness - 50 to 75 mm
- Facet width varies from 16 mm at rail head centre to 6 mm at rail head corner

The abrasive grain particles of the grinding wheel are the cutting tools and the bond material is the tool post holding the cutting tool. Each grinding wheel contains thousands of abrasive grain particles

<u>2.Rail Lubrication</u>

In absence of lubrication, an important friction occurs, what could cause a surface plastification followed by the formation of cracks.

There are two types of lubrication:

• Track mounted rail lubricators: rail is lubricated by direct application of the grease on the rail side;

• Wheel flange lubricators on the train: grease is first applied on the flange, which, in its turn, will be transferred to the rail.

A project between 1988 and 2001, carried out by the Laboratory of Contact Mechanics the National Institute of Applied Sciences, INSA, Lyon within the framework of the research project to optimized greasing (GOURROU), has demonstrated the importance of a regular lubrication. The project also showed that an extended absence of lubrication results in irreversible damage. The friction coefficient μ depends on the lubrication type used. A lubricated surface will reduce in most cases significantly the crack formation but once the crack is formed, lubrication can facilitate crack propagation.

<u>3. Head checks treatment:-</u>

Once head-checks are discovered, corrective measures have to be carried out. It is possible to act in several ways: modification of maintenance techniques by re-profiling or friction modifiers.

A)Compensatory grinding or re-profiling

The purpose of compensatory grinding is to optimize the size and place of the wheel-rail contact point, resulting in a better distribution of stress and even a decrease of these stresses in the gauge corner area involved. A rail profile optimization will help in controlling wear and fatigue defects development; in certain cases, it can also facilitate curve guiding; the rail is artificially worn and then gets an adapted profile with a bigger zone of contact.An example is the "Balliges profile" developed in Austria, asymmetrically grinded rails.This profile relieves the gauge corner by displacing the rail-wheel contact point more to the top of the rail.

B)Frictions modifiers

Decreasing the friction coefficient in the rail wheel interface is a way to cope with tensile strength. This is possible by using friction modifiers (FM). Lubrication helps in reducing the tensile strength maxima; it is especially efficient for the gauge corner. On the other hand on the top of the rail, the friction coefficient should remain optimal, i.e. higher than 0.3 to guarantee good braking and acceleration conditions. Friction modifiers are a thin layer consisting of water and one or multiple composite polymer(s) to be applied to rail material surface periodically. They present two interesting characteristics:

• reach an intermediate friction coefficient. Tensile strength will be reduced without affecting adherence and braking resistance;

• once water is evaporated, friction modifiers help in setting up a thin dry film which will remedy, to a certain extent, crack propagation problems.

So friction modifiers reduce crack formation and do not facilitate crack propagation. It is important to remember, as already mentioned on §2.2, that the friction coefficient must be neither too high nor too low.

Tests (The effects of top rail friction to modify wear and rolling contact:full scale rail test wheel rig evaluation, analysis and modeling, Wear 265 (2008), pp. 1222-1230) have estimated the influence of the friction modifier KELTRACK on the rail wear and on head checks. Results are presented in figure 16.with tensile strength T and normal strength N.

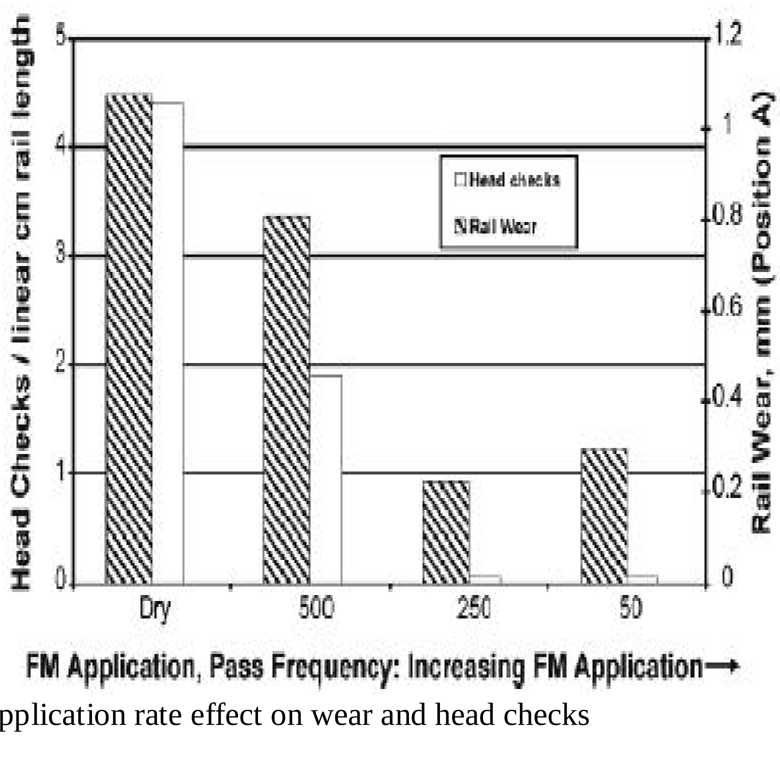

Figure 16 - Application rate effect on wear and head checks

4.0 Conclusion- The Rail Grinding and Head Check Treatment through re-profiling of rail or use of friction modifiers is very important maintenance tools to increase the life of rails. The Rail Grinding eliminates rail corrugation & reducing the crack distracting process, wear & minimize the fatigue.

Re-profiling of rail results in better distribution of stress and decreases the stress in gauge corner area & control wear and fatigue defect development. The friction modifiers reduces crack formation and do not facilitates crack propagation.

Bibliography :-

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