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Wheel Rail Rolling Contact

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Abstract—

Wheel has a continuous single point contact in the time forms a straight line. The wheel center is given by a straight line parallel to the foundation, passing through permanent center of rotation. So, the wheel rail contact force has no contribution originating from the wheel inertia in vertical direction. The change in the contact point forms no more a straight line in the time domain. This occur due to any irregularities in the wheel rail interface. Irregularity can occur either on rail or on the wheel.

Keywords—

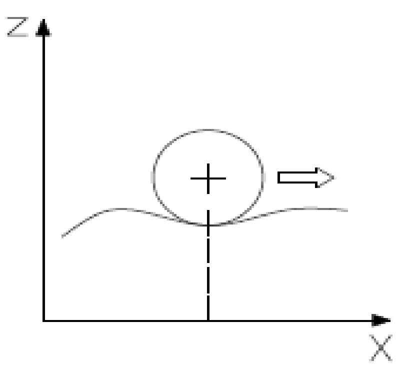
Irregularity, Wheel Rail interface, Wheel Irregularity, Point Contact

I. Introduction

There are two different types of rolling wheel contact. The consideration of perfectly circular wheel rolling on a flat rigid foundation, which the cross sectional plane is perpendicular to the wheel axis.

On the surface of rail, which is not perfectly straight line and on the wheel circumference of which is no longer perfectly circular. In this work, the finite wheel and rail width, as well as geometric variations in the transverse direction are disregarded.

Now consider a contact which is no longer form a straight line in time. It is depends on the curvature of this line. A basic in rolling wheel contact can be made between continuous single point contact, and double point contact along the wheel circumference.



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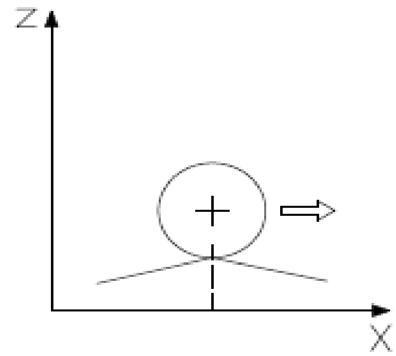

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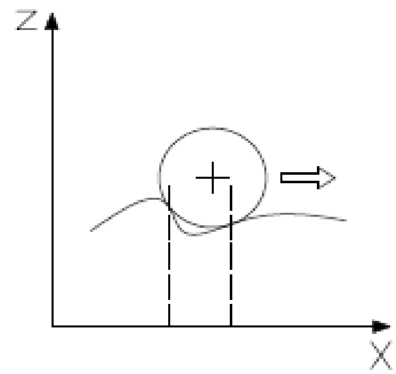

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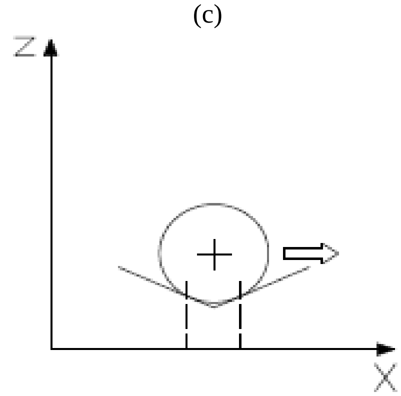

(d)

Figure 1 – Continuous Single Pint Contact in Figure (a and b) and Transient Double Point Contact in Figure (c and d)

Irregularity along the wheel rail interface give rise to “dynamic amplification” of the static wheel load in the first case. In the second case however they load to impact loading. Both loading types of the wheel rail system are essential different. The criterion for transient double point contact not to occur in that the upward curvature of the wheel rail interface geometry for the running wheel along the rail may not exceed the circumferential wheel curvature, which is equal to inverse of its radius. It can be

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also formulated as the upward curvature of the contact geometry experienced by rolling wheel at time moment should not exceed the circumferential wheel curvature. It can be conclude from figure - 1 that, transient double point contact occur automatically if an upward kink occurs in the geometry along the rail, even for minimum angle.

This phenomenon is typically the case for dipped rail joints. In actual position, this effect can be find by the finite size and the elasticity of the wheel rail contact patch, which is never a real 'point'.

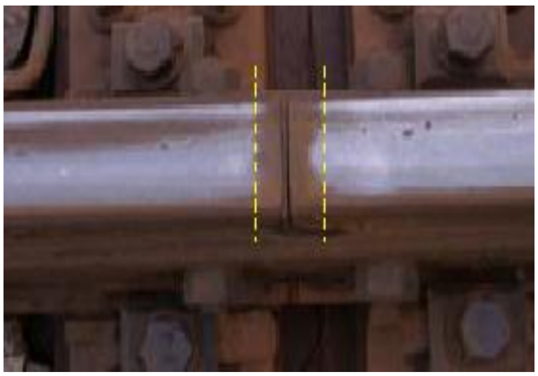
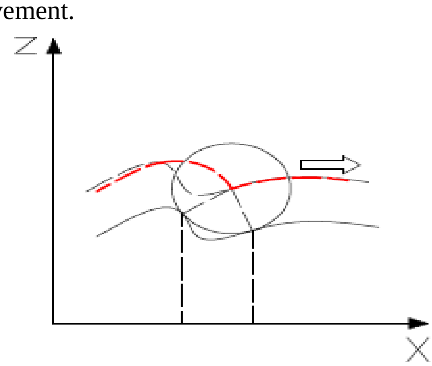


Figure 2 – Rail Joint with transient double point Contact

With regard the application in the field, transient double point contact should be avoided as possible in railway track. The resulting impact loads are determine for both the track and train vehicle. Transient double contact points typically occurs at dipped insulated or bolted rail joints and severe wheel flat but also noise in switches. One more reason why potential transient two point contact situations should be avoided, apart from the result of high vibration level and finally high noise level.

II. Contact discontinuity types leading to wheel rail impact

Impact occurs for two point contact situations can be seen, when the kinematical wheel gravity center trajectory is considered. Figure (3) shows the special and temporal trajectory for two point contact situations, indicating discrete change in vertical movement.



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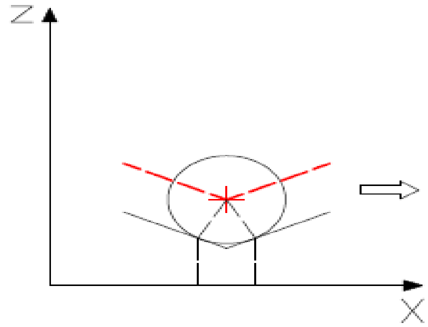


(b)

Figure 3 – Wheel Center trajectory for transient two point contact situation

Time derivative of the trajectory represent vertical wheel mass velocity. This discontinuous implies the wheel mass is vertical linear momentum, which is manifest as an impact in rolling contact shown in figure (4). In figure discrete change in vertical velocity v of the wheel mass m, implement a discrete change in vertical momentum p and manifest as an impact in its time derivative. The dynamic force, attending the effect of non – zero elasticity in the contact position.

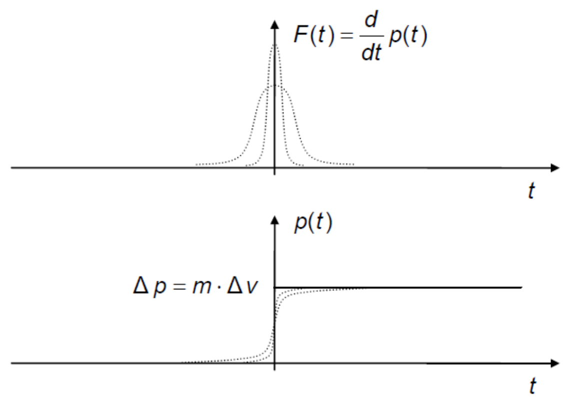
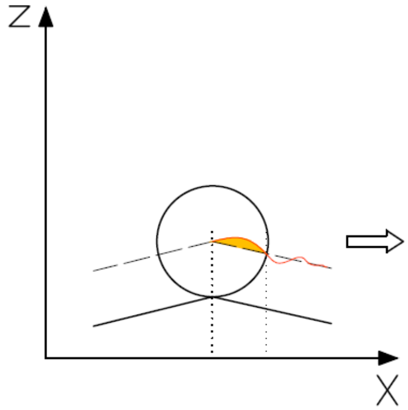


Figure 4 – Discrete change in Vertical Velocity

It is observe from figure (3.a) is that, wheel center trajectory which is not equal to the longitudinal surface geometry of supporting structure. Curvature of surface geometry, has a same order of the magnitude as the circumferential wheel curvature then the effect must be taken into account. And for smaller curvature of surface geometry, the effect is negligible.

Geometrically induced transient double point contact is inclusive condition of wheel rail impact occurrence. In figure (1.c), the kinematical trajectory of the wheel center has a discontinuous derivative in space or time. However, no two point contact occur. So, for all condition, impact will occur in the case of any non – zero velocity, because of non – zero wheel inertia which lead to successive contact loss and recovery. For smooth surface geometry contact loss is depends upon the velocity.

In transient double point contact and successive contact loss and recovery, the impact arise from same principal, which is known as jump along the wheel circumference. Sometimes the generation mechanism of booth impact type is different. In first case it may be denoted as geometrically or kinematical induce impact whereas in second case it may be denoted as dynamically induced impact because wheel inertia is activated. In first case, kinematical trajectory is consider for finding impact and in second case dynamic or real trajectory must be considered. Ultimately wheel rail contact geometry is responsible for impact occurance.



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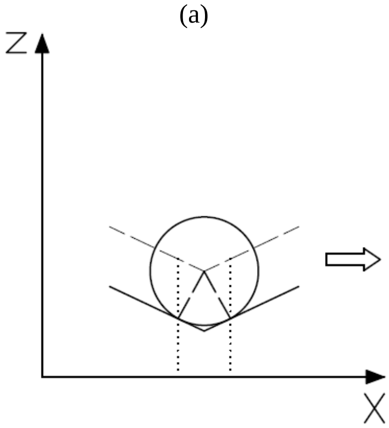

(b)

Figure 5 – (a) Implicitly geometrically determine impact – successive contact loss and recovery (Dynamics Wheel trajectory)

(b) Explicitly geometrically determine impact – transient double point contact (Kinematical trajectory)

For second case, we speak to implicitly geometrically determine for particularly successive contact loss and recovery. And for first case, we speak to explicitly geometrically determine impact for transient double point contact. The magnitude or length of contact jump along the wheel circumference is measured for the impact magnitude for real wheel rail contact situation with finite stiffness. Occurrence of single point contact in time is sufficient condition to avoid impact.

III. Effect of Wheel Rail contact condition on track and wheel set

In practice heavily corrugated rails or rails being several affected, which may be by squats are particularly noisy during train passage. It means wheel rail contact is not continuous and the contact history in the time domain consist of series of transient contact condition with impact. These impact may depends on the exact geometry which may be explicitly or implicitly or both type may occur. These successive impact load to extremely rapid crack propagation, in the presence of squats or other RCF defects, and the severe risk or rail fatigue.

Further rail fixation may get loss, concrete sleeper may crack and the ballast are locally 'DE compacted'. The development of these mechanism by practice. Use grinding for this stage before rail become 'noisy'. The noise level that rail produce, being directly related to the contact and loading condition. Therefore can be considering as a measure of their expected life time, disregarding corrective maintenance measured such as rail grinding. Same principal can be applied to wheel. Because a rail geometry, leading to transient double point contact manifests itself in a several increase in rolling noise level, and this opens possibilities for an easy detection method for critical defects. 'Acoustic detection' via microphones in the neighborhood of the wheel rail contact of a train running at conventional speed and registering the rolling noise.

IV. Conclusion

Rail having an irregularity then from wheel, one or two point are came in contact with rail. At the time of running condition it will produce an impact force. So, by Impact force it may chance of generate a crack or failure of track by repetitive cycling loading.

References

i. *F. W. Carter, On the action of a locomotive driving wheel, Proceeding Royal Society London, 112, 151-157, 1926*

ii. *K. L. Johnson, The effect of spin upon the rolling motion of an elastic sphere on a plant, Journal of Applied Mechanics, 80, 332-338, 1958*

iii. *K. L. Johnson, The effect of tangent contact force upon the rolling motion of an elastic sphere on a plant, Journal of Applied Mechanics, 80, 339-346, 1958*

iv. *P. J. Vermeulen, Contact of non spherical elastic bodies transmitting tangential forces, Journal of Applied Mechanics, 13, 338-340, 1964*

v. *J. J. Kalker, On the rolling contact of two elastic bodies in the presence of dry friction, Doctoral Thesis, Delft University of Technology*

vi. *J. J. Kalker, A fast algorithm for the simplified theory of rolling contact, Vehicle System Dynamics, 11-13, 1982*

vii. *J. J. Kalker, Three dimensional elastic bodies in rolling contact, Kluwer Academic Publications*

viii. *H. Kruse, A modular algorithm for linear, periodic train track models, Archive of Applied Mechanics, 71, 473-486, 2001*

ix. *T. D. Armstrong, Use of a reduced scale model for the study of wheel rail interaction, Journal of Rail and Rapid Transit, 220, 235-246, 2006*

x. *C. Esveld, Modern Railway Track, 2nd Edition, MRT Productions, the Netherlands, 2001*