A Review on Wiper Blade System's Squeal Noise & it's Vibration

Prathamesh Deshpande[1], Bharati Dhamdhere[2], Pranoti Deshpande[3]

[1]*Assistant Manager, Ador Welding Limited, Pune - 411019*
[2]*Senior Officer, L&T Heavy Engineering Division, Gujrat- 394510*
[3]*Research Trainee, KBCols sciences, 100 NCL Innovation Park, Pashan, Pune - 411008*

Abstract - *Windscreen wipers should operate as silently as possible, since any noise they produce can cause a distraction to drivers. This is an increasingly challenging requirement as new vehicles become quieter.* This paper is concerned with the squeal noise of a wiper/windscreen contact. *It is shown that squeal noise stems from friction-induced self-excited vibrations in the context of Stribeck's law for friction coefficient. Running a wiper system on a car windshield leads to many vibratory phenomena that may be harmful to the driver. Our main purpose in this paper is to study chaotic attitude behavior and the problem of chaos control on an automotive wiper system. Numerous vibrations that may be harmful to the driver can be observed when a wiper, driven by an automotive windshield wiper system, is operational. These vibrations reduce the comfort of driving. The dynamic behaviors of the wiper system are studied to find an effective way to controlling vibrations.*

***Key Words*: Squeal noise, Elastomers, Chaotic motion.**

1. INTRODUCTION

Car windscreen wiper blades are widely used in the automotive industry. The studied dynamic system consists of a single degree-of-freedom mass-spring-damper oscillator submitted to a velocity depe1ndent frictional force which follows the Stribeck law. Among the large variety of frictional noises that may be encountered in nature and industrial mechanisms document. The contact between windscreen wiper and windscreen was simulated by loading and sliding a 10mm section of rubber wiper profile against a glass plate specimen, using a commercially available tribometer.

2. LITERATURE REVIEW

2.1 J. Le Rouzic et al. studied the squeal noise of wiper contact with windscreen. The squeal noise comes from friction-induced self-excited vibrations. They focused on the instability range of velocities and not on amplitude of cycle. The system consists of mass spring and damper oscillator submitted to a velocity dependent frictional force which follows the Stribeck law. The analysis is done by Lyapunov method and results in a stability criterion. The experiment performed on glass contact lubricated with water. The noise come from contact is explained by mathematical modeling. The most important result concerns the prediction of the velocity range of instabilities. The measurement of friction coefficient verses sliding velocity explains the squeal noise. The damping factor and frequency controls the shape of stribeck's curve. The noise level can be control by tuning the interface between glass and rubber, by choosing an appropriate surface coating or by optimizing the roughness of wiper lip.

2.2 Daniele Dini et al. studied friction induced vibrations of frequencies between 500 and 3500 Hz. It includes the FEA model of glass and wiper. The induced noise is recorded by microphone is observed in two frequency range (close to 1000 Hz and range between 2000 and 2500Hz). These frequencies are coincides with frequencies of first two bending modes, predicted by finite element model. The experiment shows that the thickness of glass does not have any effect on noise which comes in contacts. The presence of water in contact regulates frequency and amplitude of the emitted noise by effectively adding mass to the vibrating system. The vibration is caused by high contact angles preventing water reaching the contact. The conclusion is that by decreasing surface energy of glass to prevent water reaching contact we can reduce noise. For this we have to coat the glass by hydrophobic coating.

2.3 N. P. Hoffmann et.al. The influence of a LuGre type friction law on the fundamental mechanisms resulting in linear instability of steady sliding in point contacts is investigated. In this study velocity dependent kinetic coefficient as well as mode-coupling is considered. The destabilizing effect of a kinetic friction coefficient decreasing with relative sliding velocity reduces when the rate-dependent effects of LuGre type friction become marked. In most of cases LuGre type act stabilizing and also limiting cases destabilization through changes in the damping matrix is also conceivable. Consider the example of brake squeal often a large number of unstable modes are predicted, although the tribology of the friction interfaces in these systems strongly suggests rate dependent friction laws based on internal variables. Therefore it might seem promising to reconsider the stability characteristics of the multi degree freedom brake systems by applying validated rate and state friction model. Another idea might be found in the observation that a rate-dependency of friction may eliminate the destabilization mechanism corresponding to a kinetic friction coefficient decreasing with relative sliding velocity.

2.4 Shun-Chang Chang et. al. studied the running wiper system of a car. The car wind shield leads to vibration concept which may harmful to driver. The noise may get generated by vibration. In most of automotive wiper chatter vibrations are occurs. This will affect the comfort of driving.

The chattering is self-excited vibration which based on a stick-slip phenomenon. The chatter is occur within particular limit after this there is no vibrations in the system. For examine this Lyapunov exponents is used. To obtain characteristics of nonlinear wiper system numerical method including, time response, Poincare map, frequency spectra and the largest Lyapunov exponent are used. Wiper system uses the properties of synchronization phenomenon. By decreasing chaotic motion we can improve wiper system.

2.5 A. Koenen et.al. Studied that wiping system of a car contain reciprocating motion of rubber blade on glass. A good wiping system spared water without noise generations and limiting value of noise phenomenon of wear. This wiping is only possible by understanding the tribological, mechanical, vibro-acousics parameter that controls contacts. They also studied typical phenomenon occurs in wiper blade contacts. The high elasticity of rubber makes more difficult the application of the Stribeck curve and also a very thin water film intercalated between rubber and glass increases stick-slip phenomenon. A good coating on rubber induces this phenomenon. We need to adapt method of coating in order to reduce tricky friction.

2.6 Shun chang chang et.al. Studied that vibration of wiper has adverse effect on driver. Lyapunov exponent gives efficient method to measure sensitivity of dynamical condition to initial condition. It shows chaos can be under control by giving another external input, called a dither signal, into the system .It improve the efficiency of nonlinear system. They concentrated on low speed wiper model. This diagram reveals that the wiper system exhibits chaotic at lower wiping speed. To improve performance of wiper system dither signals is used. The sine wave and square wave convert chaotic motion into periodic orbit when injected in front of the nonlinearity of a chaotic system.

2.7 Fabrice Deleau et.al. studied the behavior of rubber blade /windscreen .By studying normal force and impact velocity .They observe frictional instabilities in contact. The law friction state that the friction is directly proportional to the load and it is independent on sliding velocity of contact. The shearing stress at the sliding interface reaches 1–20 MPa and it is independent of the sample geometry. The impact of the cylinder radius is noted on the contact size and permits to adjust the contact density. Wet condition reveals three lubricated regimes when the speed is increased from 25 mm s-1 to 2 m s-1.

2.8 Gabor Bodai et.al. studied the dry and wet friction in wiper blade contact .This study is concern with effect of load and velocity on sliding friction on specimen. The material response is observed by DMA test and contact behavior by plain strain FEA model. The mixed friction model has considered the effect of cavitation, surface roughness and elastic deformation simultaneously. Experiment shows that the low coefficient of friction cannot be explained by the hydrodynamic effect i.e. it arises possibly from thin film lubrication.

2.9 Dongki Min et.al studied the wiper model of automotive and found that the friction between rubber and glass is primary factor which induces noise. The noise doesn't occur periodically. By spreading various fluid, the variation in normal forces and tangential forces on wiper blade is measured and also coefficient of friction was found. After spraying different washer fluids, the variation of the tangential and normal forces acting on the wiper blades by the moving windscreen glass was measured and also the coefficient of friction was determined. The decreased normal force caused the blade to slip from the glass without difficulty, which made it easier to generate a resonant vibration. By this set up we can find optimal properties of system without affecting its performance.

3. CONCLUSION

This research is aimed at understanding the mechanisms that give rise to friction induced noise in automotive windscreen wipers. The relations between the fundamental mechanisms leading to destabilization of steady sliding and a rate-dependent friction characteristic of the LuGre type have been understood. The rubber formulation should include the modulus and the tangent modulus, which have an influence on dry friction. We need to adapt the treatment and coating in order to reduce the tacky friction.

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BIOGRAPHIES

Prathamesh M. Deshpande was born in India on 1992. He has received M.TECH MECHANICAL DESIGN from Shivaji University.

Bharati Dhamdhere was born in India on 1993. She has received B.E. MECHANICAL from Pune University. She has expertise in Vessel, Exchanger & Flare Design.

Pranoti M. Deshpande was born in India on 1996.She has received B.E.BIOTECH. ENGG. From Shivaji University. She has expertise in Biotechnology field. .