Optimization of Monoblade Windshield Wiper System to Improve Wiping Actuals in the Residual Area

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Abstract — A single wiper mounted to a conventionally located, non-centre wiper post is adapted to wipe generally a rectangular windshield. A primary arm and wiper blade are long enough to cover a main wipe pattern that covers most of the driver side of the windshield. To cover the residual area on the passenger side, a secondary arm and blade pivoted to the tip of the primary arm are continuously pivoted by a drag link over a supplemental wipe pattern. The ultimate aim of the project is to calculate the optimal design parameters of the secondary wiping element and the appended area covered in the residual area.

Keywords: Wiper, Windshielded, Residual area, Primary arm, Secondary arm.

I. INTRODUCTION

A. Windshield Wiper Systems

A windscreen wiper or windshield wiper is a device used to remove rain and debris from a windscreens or windshields. Almost all motor vehicles, including trains, aircraft and watercraft, are equipped with such wipers, which are usually a legal requirement. A wiper generally consists of an arm, pivoting at one end and with a long rubber blade attached to the other. The blade is swung back and forth over the glass, pushing water from its surface. The speed is normally adjustable, with several continuous speeds and often one or more "intermittent" settings. Today, most of the vehicles use electric windshield wipers for granted. The wipers faithfully keep the window clear, moving back and forth across the windshield countless times as they sweep the water away.

B. Power and Gear Reduction

Wipers may be powered by a variety of means, although most in existence today are powered by an electric motor through a series of mechanical components, typically two 4-bar linkages in series or parallel. Vehicles with air operated brakes sometimes use air operated wipers, run by bleeding a small amount of air pressure from the brake system to a small air operated motor mounted just above the windscreen. These wipers are activated by opening a valve which allows pressurized air to enter to the motor. The wipers' speed was therefore variable with car speed. When the car was waiting at a crossroad, the wipers were not powered, thus a handle under the speedometer allowed the driver to power them by hand. It takes a lot of force to accelerate the wiper blades back and forth across the windshield so quickly. In order to generate this type of force, a worm gear is used on the output of a small electric motor. The worm gear reduction can multiply the torque of the motor by about 50 times, while slowing the output speed of the electric motor by 50 times as well. The output of the gear reduction operates a linkage that moves the wipers back and forth. Inside the motor/gear assembly is an electronic circuit that

Senses when the wipers are in their down position.

C. Linkage

A short cam is attached to the output shaft of the gear reduction. This cam spins around as the wiper motor turns. The cam is connected to a long rod; as the cam spins, it moves the rod back and forth. The long rod is connected to a short rod that actuates the wiper blade on the driver's side. Another long rod transmits the force from the driver-side to the passenger-side wiper blade.

D. Wiper Blades

Wiper blades are like squeegees. The arms of the wiper drag a thin rubber strip across the windshield to clear away the water. When the blade is new, the rubber is clean and has no nicks or cracks. It wipes the water away without leaving streaks. When the wiper blades age, nicks or cracks form, road grime builds up on the edge and it doesn't make as tight a seal against the window, so it leaves streaks. Sometimes you can get a little extra life out of your wiper blade by wiping the edge with a cloth soaked in window cleaner until no more dirt comes off the blade. Another key to streak-free operation is even pressure over the length of the rubber blades. Wiper blades are designed to attach in a single point in the middle, but a series of arms branch out from the middle like a tree, so the blade is actually connected in six to eight places. Some wiper manufacturers make a special winter blade with a rubber boot covering the arm assembly to keep snow and ice out.

E. Wiper Controls

Most wipers have a low and a high speed, as well as an intermittent setting. When the wipers are on low and high speed, the motor runs continuously. But in the intermittent setting, the wipers stop momentarily between each wipe. There are many different kinds of switches for wipers. Some cars have just one intermittent speed, others have 10 discrete settings and still others have a sliding scale that can be set for almost any time interval. Whichever kind of controls your car has, setting them just right can be tricky -- too fast and the windshield gets dry and the wipers squeak; too slow and your visibility is blocked by raindrops. Compounding this is the fact that the amount of water hitting the windshield changes as your car speeds up and slows down. It can require almost constant attention to keep the wipers operating properly. Carmakers may finally have conquered this problem with the holy grail of wiper technology -- the rain-sensing wiper.

1) Swab Area: The actual area which is covered by the wiping element under wiper system use.
2) Residual Area: The actual area which is not covered by
the wiping element under wiper system use.
3) Superimposed Area: The actual common area which is covered by both wiping elements under wiper system use in Tandem or Opposed Type Wiper Systems.
4) Wipe Length: The length of the wiping element used in the wiper system.

II. PROBLEMS IDENTIFIED IN THE MONOBLADE WIPER SYSTEM

A. Optimization of Swab Area

The wiper manufactures all over the world involved in the research and development for improvement of swab area of the monoblade wiper system. Also, such updations of product do not disturb the factory installed settings of the vehicle. The updated wiper system should also meet the wiper standards of the product. A complete study is required on the various monoblade windshield wiper systems. Such study leads to identify the following parameters in the wiper system as represented in Fig 1.

1) Increased Swab Area offered by the Secondary wiper.
2) Optimal Length of Secondary Wiper.
3) Minimal Superimposed Area offered by the Secondary Wiper.

III. WIPER SYSTEM

Windshield wipers are used to clean the windshield of a car so that the driver has an unobstructed view of the road. A typical wipe angle for a passenger car is about 67 degrees. The blades are 12-30 in (30-76 cm) long with lengths increasing in 2-in (5-cm) increments. The first windshield wipers were brushes. Inventor J. H. Apjohn came up with a method of moving two brushes up and down on a vertical plate glass windshield in 1903. Windshield wipers are designed and made to clear water from a windshield. Most cars have two wipers on the windshield, and they may have one on the rear window and one on each headlight. The wiper parts visible from outside the car are the rubber blade, the wiper arm holding the blade, a spring linkage, and parts of the wiper pivots. The wiper itself has up to six parts called pressure points or claws that are small arms under the wiper.
1) Overall Windshield Area \( A_{A} = 0.753 \text{m}^2 \)
2) Existing Swab Area \( A_{S} = 0.268 \text{m}^2 \)
3) Existing Primary Wipe Length \( P_{L} = 0.46 \text{m} \)
4) Existing Residual Area \( A_{R} = 0.488 \text{m}^2 \)

Also, for the validation purpose and fine tuning of design intents, additionally other parameters are taken. These estimations are taken for Maruti Suzuki – ALTO. The various parameters are calculated using CATIA V5 Platform with Animated Constraints Support.

C. Novel design

To improve the wiping performance, the study took place on the following parameters:

- **Constant Wipe Length:** Enhancement in the primary length will improve wipe performance but it cannot be altered because enhancing wipe length will result in the collision of wiper at the top edge of the windshield.
- **Variable Wipe Length:** The variable wipe length option suits because enhancing wipe length will result in the collision of wiper at the top edge of the windshield.
- **Residual Area:** To improve the wiping performance, the study took place on different parameters:
  - **Constant Wipe Length:** Enhancement in the primary length will improve wipe performance but it cannot be altered.
  - **Variable Wipe Length:** The variable wipe length option suits.

D. Design in detail

The Primary wiper stationed at 0° and will start wiping incrementally from 0° to 68° and re-stationed at 75°. This wiping will cover the area of 0.268 m². The movement of wiper is shown in Fig 5.

The Updated secondary wiper stationed at 5° and will start wiping incrementally from 0° to 47° and re-stationed at 52°.

![Fig. 5: Existing swab area](image)

E. INTRODUCTION of catia

CATIA (Computer Aided Three Dimensional Interactive Application), developed by Dassault Systems, France, is a completely re-engineered, next generation family of CAD/CAM/CAE Software solutions for Product Lifecycle Management. Though its exceptionally easy to use and state-of-the-art user interface, CATIA delivers innovative technologies for maximum productivity and creativity, from the inception concept to the final product. CATIA reduces the learning curve, as it allows the flexibility of using feature-based and parametric design.

CATIA provides three basic platforms: P1, P2, and P3. P1 is for small and medium-sized process-oriented companies that wish to grow toward the large scale digitized product definition. P2 is for the advanced design engineering companies that require product, process, and resource modeling. P3 is for the high-end design applications and is basically for Automotive and Aerospace Industry, where high quality surfacing or Class-A surfacing is used.

The subject of interpretability offered by CATIA V5 includes receiving legacy data from the other CAD systems and even between its own product data management modules. The real benefit is that the links remain associative. As a result, any change made to this external data gets notified and the model can be updated quickly.

V. DESIGN CALCULATION

A. ESTIMATION OF RESIDUAL AREA

From the updated Wiper system, the Overall Swab Area is calculated as follows:

- Overall Windshield Area \( A_{A} = 0.753 \text{m}^2 \)
- Primary Wipe Length \( WL_{p} = 0.46 \text{m} \)
- Existing Swab Area \( A_{S} = 0.268 \text{m}^2 \)
- Secondary Wipe Length \( WL_{s} = 0.33 \text{m} \)
- Updated Swab Area \( A_{U} = 0.471 \text{m}^2 \)
- Superimposed Area \( A_{\text{superimposed}} = 0.015 \text{m}^2 \)

B. CALCULATION OF EXISTING RESIDUAL AREA

\[
\begin{align*}
A_{R} &= A_{A} - A_{S} \\
A_{R} &= 0.753 \text{m}^2 - 0.268 \text{m}^2 \\
A_{R} &= 0.485 \text{m}^2
\end{align*}
\]

Existing Residual Area \( A_{R} = 0.485 \text{m}^2 \)

C. CALCULATION OF UPDATED RESIDUAL AREA

\[
\begin{align*}
A_{U} &= A_{U} - A_{\text{superimposed}} \\
A_{U} &= 0.471 \text{m}^2 - 0.015 \text{m}^2 \\
A_{U} &= 0.456 \text{m}^2
\end{align*}
\]
A_o = 0.753 m^2 
A_us = 0.471 m^2 
A_us = 0.282 m^2  
Updated Residual Area - A_u = 0.282 m^2  

D. CALCULATION OF OVERALL RESIDUAL AREA 

A_or = A_o - A_us 
A_o = 0.753 m^2 
A_us = 0.471 m^2  
Overall Residual Area = 0.282 m^2  

E. INFEREENCE 

When compared to Existing Residual Area – A_er and Overall Residual Area – A_or, the wiper covering area is enhanced to 0.203 m^2. This ultimately means that the updated secondary wiper system is capable of covering approximately 27% improvement when compared to existing wiper system. 

VI. CONCLUSION 

In this proposed design we have enhanced the overall residual area in the existing wiper system. For this we have calculated updated swab area, secondary wipe length and superimposed area with the help of CATIAV5 – Generative Shape Design Module. By updating this secondary wiper model, the device performance is approximately enhanced to 27%. Secondary wiper type manufacturing costs least when compared to tandem model.  

REFERENCE  