

Vehicle Stability Study Based on Active Sway Bar

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Abstract: Vehicle stability refers to the smooth performance and handling performance of vehicles under different road conditions and driving states. The in-depth study of vehicle stability can provide guidance and reference for vehicle manufacturers and drivers, improve vehicle safety and handling. The vehicle stability problem has been effectively solved through different technical means and control strategies, however, there are still some challenges and problems to be solved, such as, under extreme conditions, there is still some uncertainty in vehicle stability. In this paper, the lateral stability of active sway bar is analyzed, and the application and control principle of improving lateral stability are discussed.

Keywords: Active Sway Bar; Vehicle Stability Studies; Lateral Forces

1. Analysis of the causes of vehicle instability

In the course of driving, instability is a very serious problem, it may lead to traffic accidents. The reason of automobile instability can be summed up in the following aspects. The first is the car's own failure, engine failure or transmission system damage may lead to unstable power output, making it difficult to maintain a smooth running state of the vehicle. In addition, brake system failure may also cause the vehicle to suddenly slow down or accelerate, causing instability. The suspension system is responsible for supporting the body and keeping the wheels in contact with the ground. When the suspension system fails or fails, the earthing of the wheels will be affected, and the lateral stability of the vehicle will be reduced. For example, suspension spring damage or shock absorber relaxation can cause the vehicle in the process of obvious jitter or shaking.

Secondly, in some special cases, the stability of the vehicle is poor because of the design problem of the vehicle. When the vehicle is turning or steering, the mass distribution of the body, engine and occupant is not uniform, it will lead to unbalanced load transfer of the vehicle, making the contact force between the wheels and the ground uneven. This kind of non-uniform contact force will lead to the decline of vehicle lateral stability, increasing the risk of vehicle out of control. The unevenness of road surface, wet and slippery, ice and snow cover and other bad conditions will affect the vehicle's grip ability and wheel friction coefficient, and then affect the lateral stability of the vehicle. In this case, the vehicle is prone to skid, drift and other dangerous conditions, resulting in instability.

There are many reasons for vehicle instability, including power system failure, suspension system problems, uneven mass distribution and poor road conditions. Understanding these reasons is very important to improve the lateral stability of vehicles, can help us to prevent accidents and ensure driving safety. Therefore, these factors should be fully considered in the design and manufacture of automobiles, and corresponding measures should be taken to improve the lateral stability of automobiles.

2. Analysis of load transfer during vehicle steering

When a vehicle is steering in the course of driving, there will be load transfer. Load transfer refers to when the vehicle steering, there will be due to inertia and lateral acceleration caused by the body center of gravity shift, resulting in changes in tire load phenomenon. In the research of vehicle lateral stability, it is very important to analyze and evaluate the load transfer.

The load transfer is mainly related to the dynamic characteristics of the vehicle and the characteristics of the steering system. The vehicle's mass, structural stiffness and suspension system stiffness will affect the load transfer. The heavier vehicles have a greater variation in load as a result of inertia, while the lighter vehicles are relatively stable. On the other hand, the different characteristics of suspension system will also affect the load transfer. For example, semi-active sway bar systems, by actively adjusting the damping characteristics of shock absorbers, can effectively reduce load transfer during steering and improve vehicle lateral stability.

In a traditional manual steering system, the driver is connected to the steering gear and the steering rod by the steering wheel to achieve

steering. In the electric power steering system, through the motor to a certain extent to assist the driver's steering control. The quantity and speed of load transfer will be different under different steering modes because of the difference of mechanical structure and driving mode of the steering system. Different road condition is also an important factor affecting the load transfer when steering. On the straight, dry road, the load transfer when steering is relatively small, and the lateral stability of the vehicle is relatively high. However, on wet and uneven roads, because of the instability of the grip of the tires, the load transfer will be more obvious when turning, which leads to the decrease of the lateral stability of the vehicle.

The load transfer is one of the most important factors that affect the lateral stability. The quality of vehicle, the characteristics of suspension system, the steering mode and the road condition all affect the load transfer. In order to improve the lateral stability of the vehicle, it is necessary to optimize the vehicle structure, improve the suspension system and use advanced steering system to reduce the impact of load transfer, make the vehicle more stable and controllable when turning.

3. Factors affecting the side force of the tire

Tire plays an important role in the research of vehicle lateral stability. The lateral force of tire directly affects the stability of vehicle in cornering process. There are many factors that affect the tire side force, including tire parameters, road conditions and steering angle.

The tire with high lateral stiffness has strong lateral force generation ability, which can better resist the effect of lateral force, thus improving the lateral stability of vehicles. In addition, the tire tread width and tire lateral stiffness there is a certain relationship. Generally speaking, a tire with a wide tread has a high lateral stiffness, which can produce a greater lateral force, thus increasing the lateral stability of the vehicle.

The friction coefficient of road surface is closely related to the side force of tire. The greater the coefficient of road friction, the greater the friction between the tire and the road surface, correspondingly, the lateral force will increase. The uneven road surface will also have a certain impact on the tire side force. Uneven road surface will reduce the area of contact between the tire and the road surface, thus affecting the tire lateral force generation capacity. The change of steering angle will change the direction and size of tire side force. In the small steering angle, the tire side force mainly points outward, and with the increase of steering angle, the side force gradually inclined inward, until it becomes inward-pointing. Therefore, the influence of steering angle on tire lateral force should be considered in the study of vehicle lateral stability.

4. Application of active sway bar technology to improve lateral stability

Active sway bar technology is a key technology in the field of automotive engineering. It actively adjusts vehicle suspension stiffness and damping by controlling the suspension system, to adapt to different driving conditions under the road conditions and driving needs. Active sway bar technology can make the vehicle ride more smoothly and comfortably, and can significantly improve the vehicle's lateral stability.

At the heart of active sway bar technology is the efficient co-operation of sensors and controllers. The sensor can sense the vehicle's attitude, speed, acceleration and other parameters in the process of motion. These data will be transmitted to the controller for real-time Calculation and analysis. Based on these calculations and analyses, the controller can quickly respond and adjust the working state of the suspension system, control the lateral motion of the vehicle by changing the stiffness and damping of the suspension, and realize the lateral stability control of the vehicle.

One of the most common Control strategies in active sway bar is the Electronic Control Suspension (ECS) . ECS can adjust the stiffness and damping of suspension in real time according to different driving conditions and preset control algorithms to provide the best suspension working state. By changing the stiffness and damping of the suspension, the active sway bar technology can effectively restrain the roll and skid of the vehicle, improve the lateral stability of the vehicle, and provide more comfortable driving experience for the driver.

In addition, active sway bar technology can be integrated with other Vehicle Control systems, such as Vehicle Stability Control (VSC) . By working with the VSC, active sway bar technology can more accurately sense and control vehicle lateral motion, providing more reliable and safe lateral stability control. Active sway bar technology can quickly adjust the working state of the suspension system when the vehicle

is unstable or sideslip, so as to restore the stability of the vehicle as soon as possible and reduce the risk of traffic accidents.

Active sway bar is an important technology that can significantly improve vehicle lateral stability. After years of development and application, active sway bar technology has made great progress in the automotive industry and has been widely used in various types of vehicles. As science and technology continue to advance, active sway bar technology will continue to innovate and develop, bringing more advanced and reliable technology solutions to the automotive industry.

Active sway bar technology plays an important role in vehicle lateral stability research. The active sway bar system can actively interfere with the vehicle's attitude by adjusting the stiffness, damping and other parameters of the suspension in real time, thereby improving the vehicle's lateral stability. The use of active sway bar allows us to more precisely control the vehicle's suspension response during cornering, high-speed driving and other operations, thus enhancing the vehicle's handling and driving safety.

During lateral movement, the active sway bar can adjust the stiffness of the suspension in real time according to the different conditions of the road and the control instructions of the vehicle, making the suspension system more sensitive to the lateral force response. When a vehicle is facing a lateral impact, the active sway bar can provide more lateral support by increasing the suspension stiffness, thereby reducing the degree of roll and enhancing the lateral stability of the vehicle. Reasonable adjustment of suspension damping can effectively control the vehicle energy consumption in lateral motion. When the vehicle is turning, the active sway bar can choose the appropriate suspension damping to make the lateral motion of the vehicle more stable and reduce the vibration amplitude of the suspension system. By reducing lateral oscillations, the active sway bar effectively improves vehicle stability.

Active sway bar technology can also improve the vehicle's lateral stability by adjusting other suspension parameters in real time, for example, by adjusting the vehicle's downforce distribution, it can change the distribution of the lateral supporting force when the vehicle is turning, so as to improve the lateral grip of the vehicle. In addition, the height of the center of gravity of the vehicle can be changed by adjusting the suspension height of the vehicle, thus affecting the lateral stability of the vehicle.

By adjusting the stiffness, damping and other parameters of the suspension in real time, the active sway bar system can improve the vehicle's lateral stability and enhance the vehicle's handling and driving safety. In the future of automotive engineering, active sway bar technology will continue to grow, providing more possibilities for vehicle lateral stability research and practice.

5. Summary

In this paper, first of all, the causes of vehicle instability are analyzed and studied, and the internal causes of vehicle instability, such as defects in vehicle design, are discussed, how to improve the performance of the vehicle to ensure the stability of the vehicle under harsh conditions is analyzed. It is found that the problem of vehicle stability is caused by the transfer of load and the influence of tire lateral force on vehicle steering direction. In this paper, the advantages of active sway bar in dealing with load transfer and tire lateral forces are discussed, and the role of active sway bar in improving vehicle lateral stability is analysed. This paper focuses on the role of active sway bar in vehicle stability.

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