

Steering Damper for Street Motorcycle

Nobuo Hara
Yamaha Motor Co., Ltd.

Pisithsak Surawichai
Yamaha Motor Asian Center Co., Ltd.

ABSTRACT

We introduce a research on steering dampers using MR fluid (Magnetorheological Fluid). In recent years, steering dampers have been used in on-road and off-road motorcycles. Steering dampers stabilize the front end of motorcycles. The advantage of a steering damper is increased stability, but hydraulic steering dampers give rise to the problem of 'Heavy Steering'.

In order to resolve this heavy steering, we need to set the restrictions on the maximum damping force and avoid it from interfering when the rider is steering. However only reducing the damping force will lead to insufficient damping force when the handle, unresponsive because of kickback, shakes.

We solved this problem with the development of an electric control damper which generates sufficient damping force at low steering angle rates and also allows for mechanically limiting the maximum damping force.

The damper design uses "Direct Shear Mode" and features a steering angle sensor built into the damper, which results in easier and smoother steering. To test its effectiveness, we installed our new steering damper and asked for feedback from riders. From the received feedback, we were able to confirm the effectiveness and efficiency of our new design as well as its superiority over other traditional designs.

In particular, we were able to improve stability when entering a corner or riding over gaps by generating more damping force from a low steering angle rate in comparison to traditional dampers. We also succeeded in keeping the nimble handling while riding by reducing the maximum damping force.

CITATION: Hara, N. and Surawichai, P., "Steering Damper for Street Motorcycle," *SAE Int. J. Passeng. Cars - Mech. Syst.* 6(2):2013, doi:10.4271/2013-01-0111.

INTRODUCTION

Currently, big motorcycles gain popularity in Asian countries. However, the road surface in some areas is still not suitable for riding at high speed because of bumps or gaps in the road. Asian people's body structure is smaller in comparison to riders from Europe or the USA. Controlling big motorcycles on a rough road surface can increase the risk of an accident as a result of kickback in the steering. This kickback jerks the motorcycle which is called the "knifing" effect. Controlling the knifing effect increases stress on the riders and increases muscle fatigue. To prevent kickback, steering dampers have been sold as aftermarket parts. Currently many competitive riders use steering dampers. A hydraulic steering damper is also used in the R1. However, reducing the maximum damper force to reduce the heaviness of the handling gave rise to the problem of ineffective control when entering a corner or shaking occurred when driving

over gaps. For this reason, we require the most suitable steering damper.

Riders who are cornering or riding pass a bump or gap when using a commonly used aftermarket steering damper (hydraulic system) the damping force needed to control the steering can interfere with the handling of the motorcycle. The result is that steering becomes heavier, which in turn negatively affects the rider's ability to control the motorcycle smoothly.

The ideal steering damper should disengage when the rider controls the steering, and should engage only when kickbacks happens. When we divide riding into three conditions, i.e. cornering, in city and on straight way, it becomes obvious when the steering damper is necessary and when it is not. For example, when cornering at low speed or passing through traffic jam in the city, the riders need to control motorcycle by handling; the damping force caused by

the steering damper interrupts the steering action creating a sense of heavy steering for the rider. In short, the steering damper negatively impacts the rider's ability to steer the motorcycle. Some of the comments we received from riders during the course of our research included negative comments such as, "rather not be used in when it rains", "can't tilt the motorcycle body well enough", "feel heaviness on tight corners". To resolve these issues, we came to the conclusion that it is necessary to reduce the damping force at the high steering rate and to change the characteristics of damping force while riding. That is why we started the research and development on an electric controlled steering damper.



Fig. 1. Riding big motorcycle on normal road

There are many different types of electric control systems, however, most use a hydraulic system.

However, the hydraulic system uses an orifice that might lead to interference in the handling of the motorcycle when the rider has to act swiftly while driving through an urban environment because of the sudden increase of damping force when the steering angle rate increases. The maximum damping force can be limited when using the MR brake (Direct Shear Mode reference no. 1). It is also possible to generate damping force from a low steering angle depending on to the current applied to the electromagnet regardless of the steering angle. As a result it is possible to suppress heavy shaking before it happens depending on the generated damping force when entering a corner or shaking because of gaps.

Adapting an electrical steering damper that utilizes MR fluid for use on motorcycles creates a wide range of challenges. However it is our contention that development of an electric controlled MR damper system offers the greatest potential to designing a steering damper that has limited damping force at high steering angles and optimizes handling from low steering angle rates.

PRESENTED STEERING DAMPER SYSTEM

The steering damper system consists (Fig. 2) of a main body (Fig. 3), controller (Fig. 4), and a switch. The signal from the steering angle sensor in the damper is used to calculate the steering angle rate. The steering angle rate is used to calculate electrical power needed for the electromagnet in the damper using maps in the controller. The damper then adjusts the damping force accordingly. As a result, the rider is able to adjust the amount of dampening force using the switch because there are many characteristic maps mapped into the controller.

MR Fluid is a mixed liquid body containing iron particles a few μm in diameter. It has two different uses. The first is VALVE MODE (upper side in Fig. 5), The other one is DIRECT SHEAR MODE (lower side in Fig. 5).

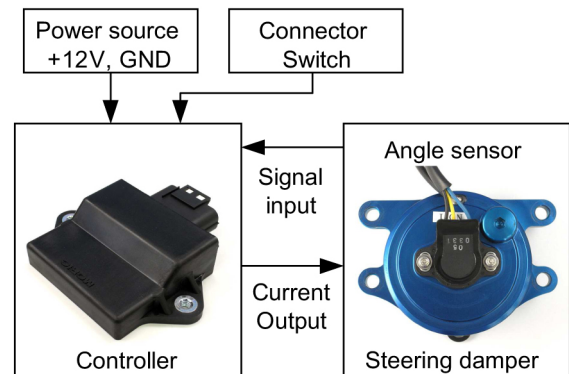


Fig. 2. Steering Damper System



Fig. 3. Steering Damper