BRAKING WHILE CORNERING ON A MOTORCYCLE WITH BRAKE STEER TORQUE AVOIDANCE MECHANISM

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KEYWORDS – Motorcycle Safety, Corner Braking, Combined Anti-Lock Brake System (C-ABS), Brake Steer Torque (BST), Brake Steer Torque Avoidance Mechanism (BSTAM)

ABSTRACT

Research Objective:
Especially in unforeseen or hazardous corner braking situations, motorcycle riders often show a limited capability to balance their brake action and compensation of the Brake Steer Torque (BST) instantaneously. The subsequent stand-up-tendency of the vehicle can further irritate the rider which might run off track or into oncoming traffic. In the early 1990ies, Weidele (1-2) proposed the so called BST Avoidance Mechanism (BSTAM) that allows the elimination of BST by lateral inclination of the kinematic steering axis. The research objective is the evaluation of a BSTAM’s performance before the background of the past decades’ tremendous improvements in state-of-the-art motorcycle technology.

Methodology:
A simple mathematical model is used to identify different influences on the steering torque demand during free cornering and corner braking for both the standard and variable BSTAM steering geometry. Focussing on the transmission of front tire contact forces towards the steering axis, the model allows to predict the quasi-stationary system behaviour and to conduct an optimization of its geometric layout. For the practical evaluation, a Honda CBR 600 RR C-ABS super-sports motorcycle (2010-Model) has for the first time been prototypically equipped with a BSTAM in cooperation with Honda. Free cornering and corner braking experiments are conducted and the measurements compared to those of the standard chassis – with and without the Honda Electronic Steering Damper (HESD) mounted (3-5).

Results:
The balance between front wheel normal and lateral force is crucial for a neutral steering feel of the rider (6). Compensating the lateral lever arm between tire contact patch and steering axis through BSTAM not only eliminates the disturbing influence of the brake force, but also diminishes helpful aligning steering torque components generated by the normal and lateral force (3). This trade-off could be overcome by lateral steering axis inclination angles of up to 14° and by moving the instantaneous centre of steering axis rotation near the front wheel hub centre. However, the telescopic fork of the prototype requires the BSTAM to be near the steering head, limiting the maximal inclination angle to less than 2°. Therefore, the driving experiments prove a significant reduction of BST kick-in, stand-up-tendency and controllability through the rider, at the cost of increased steering torque demand during free cornering (3).

Limitations of this study:
The presented approach to BSTAM geometry optimization is limited through simplifications of the mathematical model, mainly concerning chassis movements, tire-road interaction characteristics, as well as gyroscopic and inertial effects. Furthermore, test rides under controlled track conditions lack the “surprise” effect of real hazardous situations.

Conclusion:
The BSTAM concept proves effective, but still requires extensive optimization to catch up with the neutral handling of conventional chassis design. Since an accustomed “normal” feel is crucial for the acceptance of new systems, especially in the motorcycle market, an extension of existing systems with conventional chassis seems more applicable. Just adding a roll angle sensor would already allow a cornering adaptive rear wheel oriented brake force distribution, a limitation of maximal brake force gradients, and a selective application of (semi-)active steering and suspension dampers. However, the idea of a powerful counter-steer actuator underlines the important role of functional safety in the future (3-5; 7-10).
REFERENCES FOR FURTHER READING


