

Understeer

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- Explaining the Mechanism of Contribution of Understeer Reduction Function of Electronic Stability Control Systems in Overall Accident Prevention Effectiveness of Electronic Stability Control Systems

**ESC=ESP=DSC=VSC=PSM=DTSC=
Stabilitrak=AdvanceTrac= ...**

- **Electronic Stability Control Systems are known by many names**
- **In this presentation, I will refer to them as ESC**

Loss of Control Accident

- Drivers do not lose control
- Vehicles go out of control
- In at least 19% of rollover accidents, drivers are accused of “overcorrection”*
- Drivers do not “Over Correct”
- Drivers just try to keep up, but rarely succeed due to unexpected lag time

* 1999 FARS data, NHTSA

Background

- **ESC prevents many accidents, close to 88% according to some studies**
- **Actual observed accident reduction rates due to ESC are very impressive**

Background

- According to a Department of Transportation, National Highway Traffic Safety Administration (NHTSA) study based on real world crash statistical data, in the years between 1997 and 2002, ESC reduced single vehicle crashes for SUVs by **67%**, and fatal single vehicle crashes for SUVs by **63%** [1].
- According to an Insurance Institute for Highway Safety (IIHS) study by Farmer, in a statistical analysis based on all fatal crashes in the United States over 3 years, ESC was found to have reduced single-vehicle fatal crash involvement risk by **56%**[2].

[1] NHTSA DOT HS 809 790, "Preliminary Results Analyzing the Effectiveness of Electronic Stability Control (ESC) Systems"

[2] Farmer, Charles M., "Effect of Electronic Stability Control (ESC) on Automobile Crash Risk", Insurance Institute for Highway Safety, ISSN:1538-9588, 2004

Background

- According to a University of Michigan Transportation Research Institute (UMTRI) study of 262 rollover accidents that occurred between 1999 and 2001, **48½** percent of all SUV rollovers involved skidding, a dangerous circumstance that ESC was designed to prevent.[3]
- According to an Insurance Institute for Highway Safety (IIHS) study based on additional data released in 2006, ESC reduces the risk of fatal single vehicle rollovers of cars by **77%**, and SUVs by **80%**. The researchers concluded that ESC could prevent as many as 10,000, almost 1/3 of the 34,000 fatal passenger vehicle crashes that occur each year.[4]

[3] Blower D. et. al., “*Characterization of Pre-Roll Events of Sport Utility Vehicles: Data and Analysis*”, University of Michigan, Transportation Research Institute, UMTRI 2004-16 6-2004

[4] Farmer, Charles M., “*Effect of Electronic Stability Control: An Update*”, Insurance Institute for Highway Safety, June 13, 2006

Background

- According to another University of Michigan Transportation Research Institute (UMTRI) study, the estimated percentage reduction in the odds of rollover for SUVs equipped with ESC is **72.9%**. On surfaces that were not dry, the estimated percentage reduction in the odds of rollover for SUVs equipped with ESC is **88.2%**[5].

[5] Green, P.E., Woodrooffe, J., *“The Effectiveness of Electronic Stability Control on Motor Vehicle Crash Prevention”* University of Michigan Transportation Research Institute, UMTRI-2006-12, April 2006

What Does ESC do?

- **ESC prevents oversteer**
- **ESC reduces Understeer**

What Does ESC do?

- **What else takes place?**
 - **ESC controls and dampens yaw**
 - **ESC reduces speed**

Oversteer

- **The dangers of oversteer are well studied**
- **Ordinary drivers cannot correct oversteer**
- **Oversteer requires preemptive steering**
- **However, the accident reduction rate with ESC seems to exceed the number incidents where oversteer appears to be the primary cause**

Understeer

- **Understeer can be irritating to expert and demanding drivers**
- **However, understeer is usually a benign event**

Understeer

- **Understeer is defined when the vehicle turns less than the driver intended or anticipated**
- **The natural response by the driver is to steer more**
- **Expert drivers learn to recognize and deal with Understeer early in their experience**

Understeer

- **Dealing with Understeer requires nerves of steel to stop steering any more and waiting in patience while the vehicle rapidly approaches disaster**
- **This maneuver is imperative to limit side slip angles and maximize lateral traction**
- **Expert and aggressive drivers may attempt to provoke oversteer to correct the condition**

Understeer

- Many driver manuals include instructions on how to deal with Oversteer, i.e. “countersteering”
- Understeer is not generally mentioned in such literature or education
- For ordinary drivers, the only remaining rational reaction is to keep steering and hope for a response

Recipe for Disaster at Highway speeds

- **As a result, the front tires will be saturated and weight transfer will be shifted, improving traction at the front axle**
- **Tire scrub will result in reduced vehicle speed, further reducing understeer**
- **Eventually, the unsuspecting driver will be delivered a vehicle primed to oversteer with a high degree of steering wheel angle**

Rapid shift from Understeer to Oversteer

- **With Understeer finishing its course and diminishing, oversteer takes over, primed with a high steering angle and high yaw rate**
- **Ordinary drivers typically do not recognize yaw rate but recognize yaw angle**
- **By the time an ordinary driver recognizes oversteer, the yaw angle increases to significant levels**

Oversteer

- **The rest is typical Oversteer sequence, where any countersteering attempts by the driver are too late to help and usually compound the problem by overlapping with subsequent fishtail events**

Why?...

- **Abrupt steering, such as during an avoidance maneuver**
- **Road edge recovery maneuver**
- **Slippery surface**
- **Tire failure**
- **Minor impact**

Probability varies

- **Some cars are significantly more susceptible**
- **Propensity to Oversteer is one of the factors**
- **Poor transitional response**
- **Poor handling feedback**
- **Lack of steering precision**
- **Lack of progressive understeer**

Next Steps

- **Developing metrics for ESC Understeer reduction**



Thank You!
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