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REAL EFECTS OF AUTOMOBILE AUTOMATIC STABILITY CONTROL

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Abstract: *One of the most significant technologies for improvement vehicle's active safety is automatic vehicle stability control. The primary function of this technology is to assist the driver in maintaining control of the vehicle during sudden maneuvers or adverse weather conditions. This technology detects drivers steering input and compares it with true attitude of the vehicle and, depending on detected difference, activates braking system and regulates engine power to compensate for eventual difference. The automatic vehicle stability control has been highly effective in preventing single-vehicle crashes. The future studies with more data may even find reduction in some types of multiple-vehicle crashes. This paper deals with the basic characteristics of automatic vehicle stability control and its effects.*

Keywords: *Automatic, Control, Stability, Automobile*

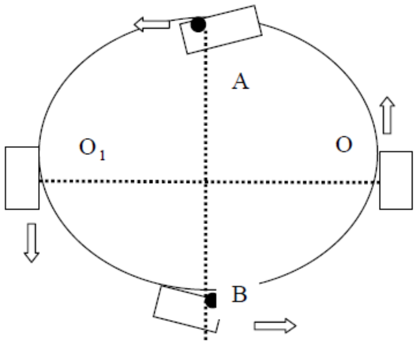
1. Introduction

In the past two decades numerous technological innovations have improved active safety of vehicles. Each new technological improvement, in this domain, has a goal to help drivers to avoid a traffic accident. One of the most important technologies is the automatic stability control (ASC). The basic function of the ASC technology is to help the driver to maintain control over the vehicle in times of sudden steering wheel maneuvers or in unfavourable weather conditions. ASC is classified as an active control vehicle congestion which uses the anti-lock brake system (ABS) function of brakes and control of the pulling force on the wheels. Detecting the drivers steering command and comparing it with the true movements of the ASC vehicle, depending on the detected difference, it activates the braking system and regulates the motor power, compensating possible differences. An ASC device is made of a sensor, brakes, motor control modules and microcomputers which constantly follow the behavior of the vehicle on the road, depending on the drivers reactions on steering. This device has showed up first in Europe in 1995, and three year later in America. The marker has many names and nicknames for this device, from which the most popular are: electronic stability control (ESC), dynamic stability control (DSC), automatic stability regulation (ASR), integrated vehicle dynamic (IVD) and so on. However, the goal and function of all these devices are the same in the basis - keeping the stability of the vehicle.

According to the data of the American national highway traffic safety administration (NHTSA) from 2004, in the three years ASC has influenced on the risk decrease of individual vehicles to participate in traffic accidents with deathly consequences by 54%, which makes for 34% decrease of all accidents with deathly consequences. In this work, a check up of the ASC characteristics and the results of numerous test and ASC efficiency analyses in real conditions is given.

2. THE CONCEPT OF AUTOMATIC STABILITY CONTROL OF VEHICLES

Automatic stability control of cars is made so that the ASC device estimates the drivers steering command comparing it to the true movement of the vehicle. If differences are detected the ASC will activate the braking system and regulate the motor power with the goal to compensate those differences. ASC system determines the movement direction, measuring the (drivers') intended and real movement direction. If this doesn't fit the drivers intent, ASC turns the car around using different forces of braking on the wheels of the vehicle. The movement speed and the turning angle of the steering wheel are used to determine the drivers' intended movement direction. The behaviours or the car is registered with a sensor which identifies the transient acceleration. If the vehicle behaves according to the drivers intent, the turn degree of the vehicle will be balances in accordance with the speed of the vehicle and it's transient acceleration. The concept of 'degree of transient acceleration' can be illustrated following the vehicle movements on a big circle drawn in a parking area. If the vehicle starts to move in that circle towards north (Picture 1, position 0) and goes over half of the way, its orientation will then be towards south (Picture 1, position 0_1). In that case, the turn of the vehicle will be changes for 180 degrees. If the movement took 10 seconds, then the 'degree of turning the vehicle' is 180/10, that is 18 degrees per second



Picture 1. Effects of stability control of vehicles in the time of excessive or insufficient steering wheel turn

If the speed is constant, the vehicle will move around the vertical axis in the amount of 18 degrees per second. If the speed is doubled, that's when the degree of the turn will double as well and it will be 36 degrees per second. In a situation of an excessive steering wheel turn (position A, Picture 1) the driver will lose control and the back part of the vehicle will start slipping. In this case, the ASC will activate the braking force on the front outer wheel, with the goal to redirect the vehicle into the original (intended) position. In a situation of insufficient steering wheel turning in a curve (position B, Picture 1) the front part of the vehicle will have a tendency to slip from the path. In this case, the ASC will activate the braking force on the inner back wheel, with a goal of redirecting the vehicle into the original path.

3. REAL EFFECTS OF AUTOMATIC STABILITY CONTROL

Potential benefits of the ASC in sustaining stability of vehicles were demonstrated in numerous testings and simulation drives. On the testing, which were done by Toyota, 45% of the vehicles without ASC has lost their stability, while only 5% of vehicles with ASC device has lost stability. Driving simulations which were done on the modern national simulator with the models Oldsmobile-Intrigue and Ford Expedition SUV 28% of the drivers without ASC and 3% with ASC has lost control over their vehicles. However, the testing results and simulation results don't have to be reliable indicators of real performances in real conditions. For example, the test results of the anti-block braking system (ABS) were impressive, but the real happenings in real conditions were disappointing. Reasons for such differences are in inadequate reactions of the drivers who were normal, average drivers and not test-drivers.

3.1. Security Effects

The first published study of real effects of ASC was done in Japan. The results of this study for three Toyota car models show a 35% reduction in vehicle traffic accidents after the installation of an ASC device. The same vehicle models, the same year of production without ASCs, had 2.5 individual vehicle accidents per 10,000 vehicles during the year, while vehicles with ASCs had 1.6 accidents per 10,000 vehicles during the year. In Germany, the ASC device became standard equipment for all Mercedes vehicles in 2000. On the basis of a sample with more than 2 million traffic accidents, researchers have registered a decrease in accidents from 1.32 in 1998-1999 to 1.10 in 2001-2002. The percentage of traffic accidents in which drivers lost control on the vehicle has been reduced from 21% to 12%. Investigators in Sweden analyzed 442 traffic accidents with injured persons in which vehicles with ASC devices and 1967 accidents of similar vehicles without ASC devices participated. It was estimated that the ASC device contributed to reducing all types of accidents by 22%, and that the number of accidents on wet highways decreased by 32%. In a study done in the US in 2004, data were compared on a "before-after" basis. The data on incidents involving individual vehicles with an ASC ("after") vehicle were compared to the previous car models ("before"). These relationships were then compared to "before-after" accident data involving more than one vehicle (control data). The ASC effects were performed using the following formula:

$$E_{ASC} = 1 - \frac{f_{ASC} / f_{BezASC}}{f_{ASC-Kontrol} / f_{BezASC-Kontrol}}$$

Gdje je:
E_{ASC} - efekti ASC uredjaja,
f_{ASC} - broj nezgoda pojedinačnog vozila sa ASC uredjajem,
f_{BezASC} - broj nezgode pojedinačnog vozila bez ASC uredjaja,
$f_{ASC-Kontrol}$ - broj nezgoda sa više vozila, sa ASC uredjajem,

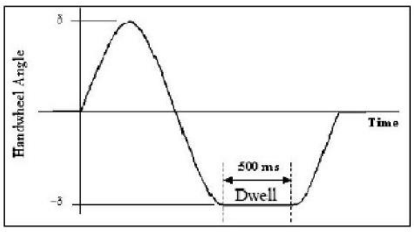
$f_{BezASC-Kontrol}$ - broj nezgoda sa više vozila, bez ASC uredjaja.

Tabela 1 Efekti ASC- a po vrstama saobraćajnih nezgoda i vozila

Vrsta saobraćajne nezgode	**Putnička vozila [%]**	**Laka teretna i kombi-vozila [%]**
Pojedinačno vozilo	35* (34)**	67 (59)
Prevrtanje	69 (71)	88 (84)
Više vozila	19 (11)	38 (16)
Ukupno	14 (18)	29 (13)

Izvor: [1] National Highway Traffic Safety Administration, US Department of Transportation, Washington, D.C., 2006.
xx* - Saobraćajne nezgode sa poginulim licima
xx** - Sve saobraćajne nezgode

Vehicle equipped with an ASC device must meet certain criteria in order to alleviate the tendency of slipping or eliminated. The slip is defined here as the final direction of the vehicle that is greater than 90 degrees in relation to the initial direction after the symmetrical maneuvering of the steering wheel, with the number of right-hand steering wheels turning identical. During this test, the vehicle is not allowed to lose its transverse stability. The test of the excessive steering of the steering wheel. To detect real ASC performances, this test uses a maneuver based on a modulated 0.7 Hz sine-directional control input. A maneuver known as the 0.7Hz Sine and Dwell maneuver is shown in Figure 2.



Slika 2. Sine i Dwell manevar

Figure 2. Sine and Dwell maneuver

Retrieved from: [1] National Highway Traffic Safety Administration, US Department of Transportation, Washington, D.C., 2006. The test uses a rotating machine that delivers the appropriate steering wheel maneuver vehicles to achieve vehicle stability during the ASC intervention. The change of steering position is initiated at a speed of 80 km / h and two series of tests are carried out. One series is with the steering wheel "from right to left" and the other "from left to right". Each series of testing begins with a moderate angle of steering rotation. The starting angle of the steering wheel is increased by each experiment in the series until the set criteria are met.

The transverse stability criteria. The transverse stability here is defined by the ratio of the "degree of rotation" at a certain point and the maximum turning point at 0.7 Hz of the Sine and Dwell "counter" rotation of the steering wheel. The maximum amount of this ratio may be 0.05, which practically means that the vehicle is equipped with an ASC slipper less than 5%. Based on this, it is required that the ASC must fulfill the following two criteria:

a) One second after 0.7 Hz Sine and Dwell maneuver the degree of turning the vehicle must be less than 35% of the maximum degree of rotation ie:

$$\frac{\psi_{(t_0+1.0)}}{\psi_{\max}} x100 \leq 35\%$$

b) 1.75 seconds after the maneuver, the degree of turning the vehicle must be less than 20% of the maximum turning point ie:

$$\frac{\psi_{(t_0+1.75)}}{\psi_{\max}} x100 \leq 20\%$$

where is:

t - degree of turning in time t,
max - maximum turning value generated with 0.7 Hz Sine and Dwell counter-rotation Controls,
0 t - steering wheel complete steering time.

Accordingly, the probability of slipping prevention is at least 95% for an ASC system that meets the specified criteria.

3.2 The effects of cost and benefits

ASC is increasingly being offered as standard or optional equipment on new car models. It is estimated that in 2006 about 30% of cars in the US were equipped with ASC, and that in 2011 about 70% of cars would have this equipment. The initial unsatisfactory results of the braking system (ABS) contributed to the slow adoption of ASCs in the US as the automatic stability control contained ABS as a component. However, the ASC does not require the driver to activate the brakes. Considering that in the previous tests this device has met the set criteria for improving active safety, and at the same time achieved a positive ratio of cost and benefits, it is to expect that the number of cars with these devices will increase rapidly. When all cars on the US roads have an ASC installed, it is estimated that the number of people killed in traffic accidents will decrease from 52000 to 10300 annually, and the number injured from 168,000 to 252,000 in relation to the 2011 level. The technological costs of developing and installing the ASCs are around $480 per vehicle, including the anti-blocking system, so that the total rising costs of installing this device by 2011 will be around $985 million, assuming an annual production of 17 million passenger cars and assuming a gradual-rising cost of 58 dollars per car. The installation of ASC in cars will prevent numerous traffic accidents and thus reduce material damage and traffic congestion due to traffic accidents. It is estimated that about 453 million dollars will be saved by installing this device on vehicles, based on material damage and traffic congestion costs. As far as fuel economy is concerned, the device will increase fuel consumption due to an increase in vehicle weight. However, this increase is negligible given that the average weight of the vehicle will increase by about 1kg, which will increase fuel consumption by about 9 liters during the car's life and will cost about $4. Net cost per saved life equivalent is estimated at around $430000 while the total value for preventing traffic accidents with fatal
estimated at $3.75 million. On the basis of the above it is predicted that the net benefits of ASC devices will be about 10.6 billion dollars.

4. CONCLUSION

Previous research and testing shows that the Automatic Stability Control (ASC) of the vehicle contributes to reducing the number of traffic accidents per vehicle by 35%. In fact, the 95 percent confidence interval indicates that this reduction is in the range of 33-48%. However, according to previous research, the ASC device has no significant impact on reducing the number of traffic accidents involving multiple vehicles. It is possible that future tests and studies that will include substantially larger samples and additional data show reduced and other types of traffic accidents. The initial unsatisfactory results of the anti-block braking system (ABS) contributed to the slow adoption of ASCs in the United States as the automatic stability control contained ABS as a component. However, the ASC does not require the driver to activate the brakes. By meeting the set criteria for improving active safety and favorable cost-benefit ratio, it is predicted that the number of cars with ASC devices will increase rapidly in the near future.

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THE USE OF MOBILE PHONE IN THE CAR AS A RISING ROAD SAFETY PROBLEM

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Abstract: *Obstruction of traffic is another risk and is becoming an increasing problem in the world. Previous studies in the field of traffic safety indicate that about 25% of all traffic accidents related to driver distraction or distraction while driving. In fact, mobile phones are now extensively used in a motor vehicle, and taking into account mobile operators increasingly offer new products or services to drivers that are useful for them (using the Internet, send and receive e-mail messages, watching movies, etc. .), the total time and the risk of using mobile phones while driving is increasing. Taking into account that the use of mobile phones while driving just as much dangerous as driving under the influence of alcohol, over the past few years, the impact of mobile technology on traffic safety has become the subject of numerous studies that aim.*

Keywords: *mobile phone, traffic accident, traffic safety*