IMPACT OF ELECTRONIC SYSTEM CONTROL OF BRAKING IN VEHICLE

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ABSRACT
Advancing of modern systems of braking in vehicle have contributed in growth safety of traffic and reduced of road accidents. Modern vehicles which are equipped with electronic control units, signaling sizes must control and compare with sizes of software of break system. These electronic control units have influence in elimination of prejudices of drivers in critic situations. In these situation electronics units have the possibility of forecasting critical situations and reactions time is shortest than reaction time of driver.
Analysis of impact of electronic system of braking vehicle is made too with software and obtained results are presented in diagrams.

Key words: electronic, break, vehicle, break force, lateral force.

1. INTRODUCTION

Break system of vehicles is part of active safety systems.
In different from passive safety systems, where the main tasks are to reduce the consequences of passengers accidents. Active safety systems have a task to prevent the occurrence of accidents.
In Figure 1, are presented active and passive safety systems in different situations during driving of vehicles. The main task of break system is to stop of vehicle, driving with speed in adaptation with:

- road conditions
- driving desire to follow the trajectory of driving
- kipping vehicle in stop position in parking
- and others.

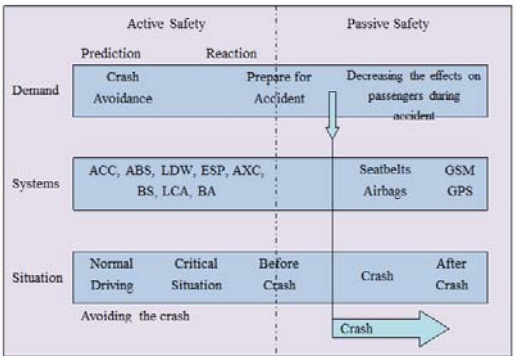


Figure 1. Active and passive safety systems in different situations during driving

Manufactured vehicles last years are equipped with large number of intelligent systems, which aim to increase active, passive and catalytic safety.

All of intelligent systems which can be mounted on the vehicle are divided into three main groups:

- Intelligent systems for starting of engine working and starting to move vehicle from static position.
- Intelligent systems which control the movement of the vehicle in traffic and
- Intelligent systems which control break and stability of vehicles during breaking process.

The basic requirements of the breaking system are:

- Stopping of vehicles,
- Reducing the speed of the vehicle and driving with desired speed,
- Increased stability during braking,
- Full breaking of vehicle
- Kipping vehicle in stop position in parking.

The rapid advancement of vehicles technology in recent years have a extensive expansion of vehicle breaking systems.
In combination of software, control algorithm and sensors, given the opportunity to use control systems such as the wheels skid control during breaking (traction control TC), electronic distribution of breaking force (EBD -electric break force distribution), support during breaking (BA break assistant) and electronic control of stability (ESC- electronic stability control ECC).
In parallel with technological advancements of braking system are also developed sensors that enable recognition of pedestrian.

Sensors that are used at the beginning of their application and sensors that use today differ more to the dimensions and the principle of work. So, we have different sensors to measure the number of rotations at the wheel:

- Inductive sensors,
- Active sensors and
- Intelligent sensors.

Also hydraulic modulators of the first generation ABS2, ABS5, ABS8, ABS8, and ABS1, are used a lot in technological aspect, while measures and their dimensions are reduced for some time.
Modern break systems of vehicles as part of active safety can be divided into systems whose main task is to anticipate events during driving (second group WW) and systems which react under the command.

Examples of system function are submitted in Figure 2.

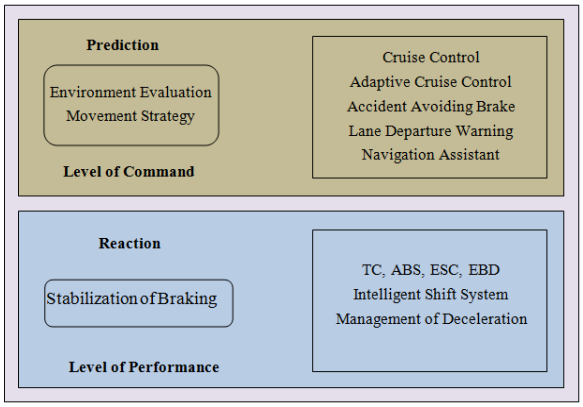


Figure 2. The example of existing systems

The main task of system in command level is to evaluate the space in which vehicle located. This means the previously determination of the position of vehicle on the road, which means does have other participants before, beside or behind the vehicle who participate in traffic, in which distance are others participate and with what speed moved. Assessment of condition of the road, respectively coefficient friction in road (adhesion) φ, make based on weather conditions and the condition of the tires. These systems have the duty to evaluate the technical condition of the breaking system, for example: wastage layer of friction of disc during exploitation in different conditions.

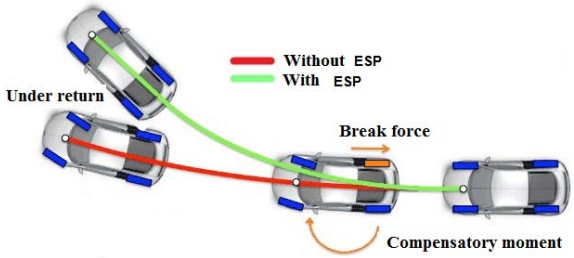
In support of these assessments and based in program, all of these sizes should be in accordance with the adhesion of wheels with road during breaking. TCS system, presents a system to prevent the wheels blocking (ABS). In this way ensure better stability during breaking and short road stopping. In the case where the asphalt is dry and new, still have good stability during breaking but vehicle road stopping grows.

2. ELECTRONIC STABILITY CONTOL

Electronic stability control ESC, is an important active safety system in modern vehicle. This system depending from manufacturers can be found with different names: ESP, ESC, VDC, DSC, VSA ect. The main task of those systems are to ensure good performance during driving the vehicle and to prevent possible accidents due to drivers losing control over the vehicle [4].
To the loss of control over the vehicle from driver may comes as a result of several consecutive manoeuvring the steering wheel, as a requirement of changing the trajectory of movement of vehicle or during changing of lane during breaking process.

In Figure 3, are presented two extreme case driving (turned) of vehicle in road with curve.

a).



b).

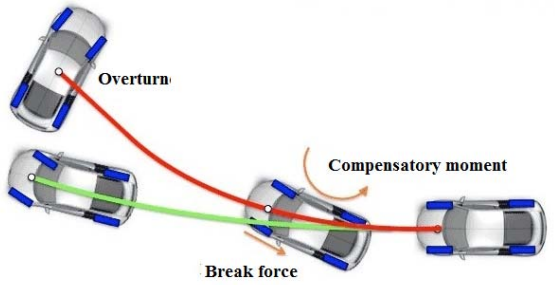


Figure 3. Submitted of driving of vehicle when have: a) under return; b) over return [3]

Until loss of control of driver over vehicle can come also in situation when vehicle move in other trajectory in report with steering position.

The driver did attempt to follow the desired trajectory of the road, but in some case fails to do so can come to over return or under return. In case when have over return front wheels return more than driver wants. This is result of reducing the coefficient of attachment in rear wheels with layer of the road. In this case rear wheels start to skid in lateral direction, Figure 3.a. When have under return front wheels return more than driver wants. When we have under return of vehicle, front wheels reduced contact with road and in this case vehicle returned less than is the aim of driver to dominate the curve, Figure 3.b.

In Figure 4. is submitted block scheme of control electronic system of stability of vehicle which include main elements: driver, vehicle and surroundings.

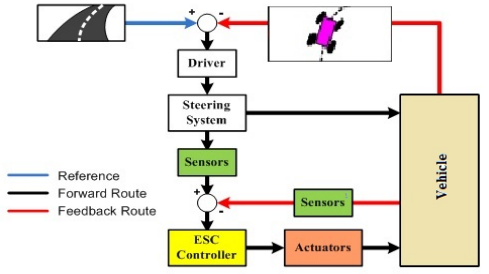


Figure 4. Block scheme of control electronic system of stability of vehicle [3]

In normal condition, driver notices the changes on the situation of the vehicle in relation to the trajectory of the given, by correcting the steering and breaking system tends to return the vehicle at the given trajectory. But, in case when the driver loses control of vehicle,

intelligent system this phenomenon accepts by receive information from a number of sensors and the electronic system in automatic way and very fast generates the moment of stability. The moment of stability operates around the centre of aggravation and consequently the vehicle back through the road where the driver wants.

These intelligent systems stabilize the vehicle using the corresponding moment stabilizing, which generated by activation of the breaking forces on specific wheels depending on the situation in which is the vehicle. At the same time doing regulation of lateral angle slip of vehicle.
Some ESC advanced systems, apart generating the momentum of stabilization during their activation, in the same time impact in reducing engine power, respectively reduces the moment of rotation which is transmitted to the wheels driver.

3. ANALYSIS OF MOVMENT OF VEHICLE WITH ABS AND ESP THROUGH PC CRASH SOFWARE

Thought very advanced program PC-CRACH is analyzed movement of the vehicle „*Mercedes Benz*“ in road with curve, which is presented in Figure 5. In this case is analyzed movement of this vehicle with speed about 100km/h, breaking about 6m/s^2 and with activated ABS and ESP systems.

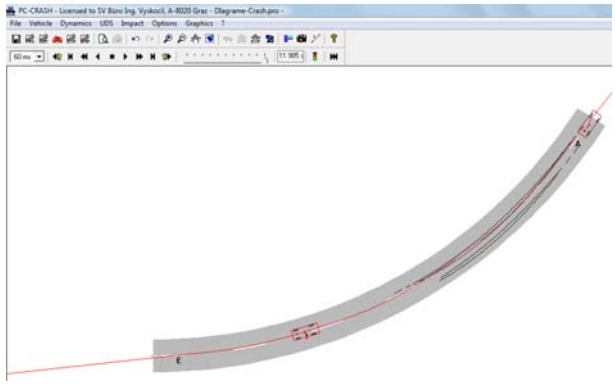
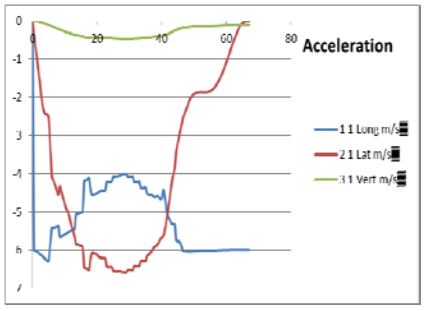
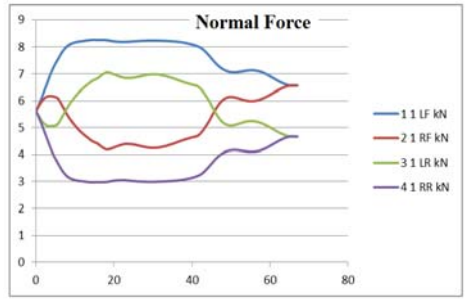


Figure 5. The movement of the vehicle with activated ESP dhe ABS [1]

The diagrams of breaking, normal forces, lateral forces and breaking forces which operate in vehicle, with activated ABS and ESP are presented in Figure 6.





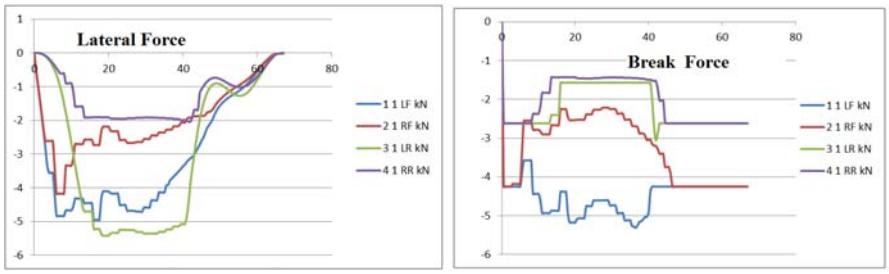


Figure 6. Obtined diagrams during movement of vehicle with activized e ABS and ESP systems

In other case is analyzed movement of vehicle with same data and in same part of road, but ABS and ESP systems are not activated (Figure 7.).

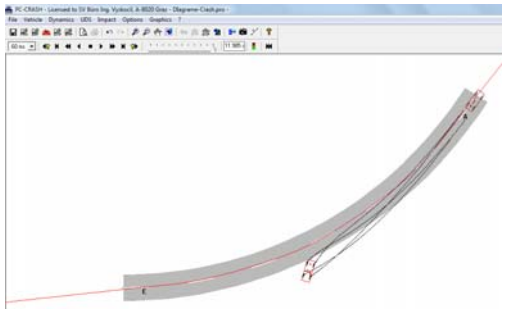


Figure 7. The movement of the vehicle without activated ESP dhe ABS [1]

The diagrams of breaking, normal forces, lateral forces and breaking forces which operate in vehicle, without activated ABS and ESP are presented in Figure 8.

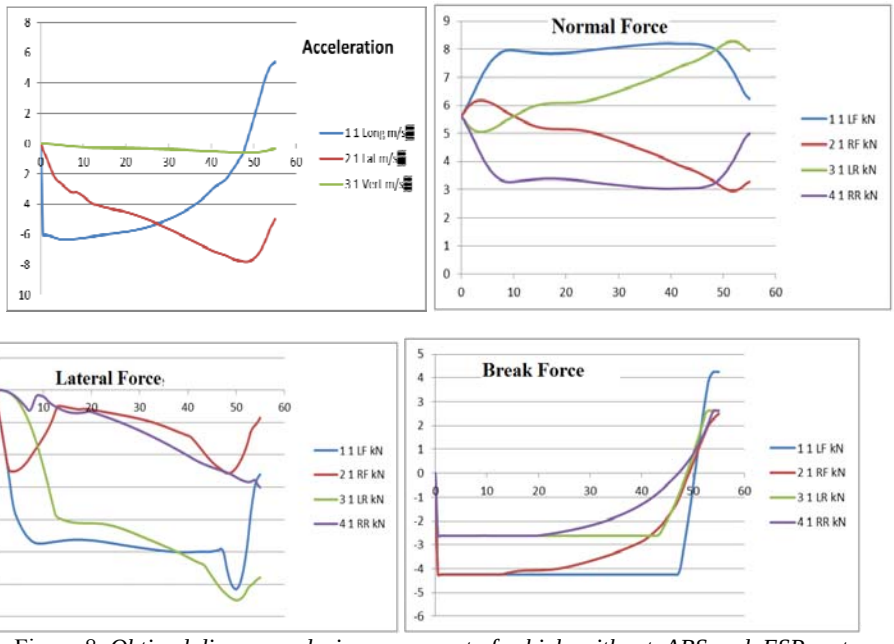


Figure 8. *Obtined diagrams during movement of vehicle without ABS and ESP systems*

From diagrams that are presented in Figure 7. and Figure 8. may conclude that the application of electronic stability program ESP, greatly improves vehicle stability during driving, breaking and acceleration. This program control break forces in specific wheels than adapts them to the conditions and current circumstances in traffic.

4. CONCLUSION

Vehicles that are equipped with electronic control systems for breaking, realize much better performance compared to vehicles with classic breaking systems.
Road of stopping during vehicle breaking is short, if it's electronic control for coefficient of attachment $\mu > 0.5$.
Also stability and driving of the vehicle in critical situations is much better.

Breaking performance of system improve with advancing of performance of intelligent systems, through which controlled driving and breaking of vehicle.

Deadline use of tyres and friction layers of break system grow, thus create conditions for saving disks and other spare parts. With electronic control of breaking system of vehicles, greatly contribute to increased traffic safety of all participants.

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