

Safety requirements for road vehicles

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Key words: technical requirements, safety of vehicle, construction of vehicle, regulatory acts, approval of vehicle

Abstract

The road safety is affected by several factors quality of infrastructure, behaviour of drivers, including their proper training and also safe cars. For the safety of vehicles in the approving process a number of regulations (regulatory acts) apply, regulating the technical requirements in the active and passive vehicle safety, but also in the environment. In the area of technical requirements for vehicles and their parts significant changes occur constantly, mainly due the progressive technological developments. A large number of regulatory acts are often changed due to the tightening. These regulatory acts relates directly to manufacturers, because their manufactured vehicles have to meet these requirements. That these regulatory instruments are evolving in the right direction proved the fact that due to better road safety the number of fatal accidents in the last two decades shrunk, although the volume of traffic has tripled. A significant progress has been achieved only through the improved vehicle safety and only in a small measure thanks to the improvement and upgrading of the infrastructure.

Introduction

Every vehicle operated on the road has to be approved. Evidence of approval of a vehicle is the vehicle registration document (Vehicle license / registration certificate). Approved vehicle must not be a source of threat to road safety, human health and life or the environment, and there shall not be any pollution or deterioration of the road. In order for the vehicle to be authorized to operate on the road it must meet number of technical requirements also called “regulatory acts”.

The field of technical requirements for vehicles and their parts is experiencing constant changes mainly due to the progressive technological developments. The proof that these regulatory acts are progressing in the right direction is the fact that due to the increased road safety, the number of fatal accidents in the last two decades has decreased,

while the volume of traffic tripled. This significant progress has been achieved due to the improved vehicle safety and, not least, through upgrading and improving infrastructure. The noise level has reduced by about 90% since the 1970, and if we stay in this period, emissions (NO_x and other toxic substances) produced by one vehicle at that time equals to emissions of hundred vehicles produced today.

Vehicle safety is also an element of competitiveness and therefore the vehicles manufacturers dedicate increased attention to this issue.

Road safety

The road safety or the prevention of an accident is affected by many interrelated factors:

1. Transport infrastructure

- Construction of roads (motorways, expressways);

- Technical condition of the roads;
 - The quality of the road surface;
 - Traffic signs (condition and level, new features, variable signing);
2. Vehicle
- Technical requirements for vehicle;
 - Active and passive vehicle safety;
 - Level of information technology used in the vehicle and outside the vehicle (early warning system);
3. Driver
- Quality of driver's training;
 - Level of driver's theoretical and practical skills;
 - The impact of preventive and educational habits (trained unconditional reflexes);
 - The level of driver's health and mental abilities;
 - New drivers tests;
 - Aggressive behavior;
 - Violation of traffic rules;
4. Organization of transport
- Redirect traffic during rush hour;
 - Intelligent Transport Systems;
 - Flyover junctions layout;
 - Introducing elements of combined and intermodal transport;
5. Safety and road traffic smoothness control
- Providing the service;
 - Ensuring the flow of traffic during rush hour;
 - Repression;
 - Objective liability;
 - Financial penalties;
 - Legal and technical environment;
 - The quality of laws and technical standards.

As seen from the above, vehicle safety is only one of many factors affecting road safety.

Vehicle safety

When developing new vehicles it is emphasized that the vehicle meets the safety requirements. These requirements are set by valid regulatory acts, but also by customers needs. In addition, vehicle manufacturers themselves are developing a variety of safety features that are intended to increase the safety of the vehicle. The main purpose of vehicle safety is life and health of the vehicle crew, but also other road users (pedestrians, cyclists, other vehicles, etc.). In general, the goal is to minimize the likelihood of an accident and if this occurs, to ensure protection of health and life. To achieve this goal it is possible to apply different features that can be called safety of the vehicle.

The term safety of the vehicle means two basic categories of safety: active and passive safety.

Active safety of vehicles

Active safety prevents the accident and is the result of harmonic chassis design, which takes into account the wheels guidance, suspension, steering feedback and breaks stability. It is manifested by optimal dynamic behavior of the vehicle also when avoiding obstacles. Steering control is not intended only as a precise transfer of movement of the steering wheel to the wheels, but should inform the driver about a power required to operate according to the state of the road surface (for example, the slippery surface). Breaks stability ensures not only keeping one foot braking on straight road, but also around the curves.

Active safety components are:

- 1) travel safety;
- 2) conditional safety;
- 3) perceptual safety;
- 4) operator safety.

Travel safety is the result of a harmonious approach to conducting wheel chassis, suspension, steering and brakes. It is visible in optimal dynamic behavior of the vehicle.

Conditional safety – is affected by psychological state (of the driver), which depends on the comfort, visibility, vibration, noise and climate impacts.

Visibility – the better driver sees surrounding traffic conditions, the lower is the risk of unexpected situations.

Vibration – affects the driver and result as disturbance (into frequency range of 1–25 Hz stuttering, tremors etc. falls also vibrations).

Noise – is manifested as audible disturbance when driving the vehicle. It can comes from within (engine, gearbox, shafts, axles) or outside (tyres, road and wind noise).

Vibration and noise impact resistance and concentration of the driver. Good sound insulation and well-balanced suspension cab reduces the noise levels, therefore can reduce the risk of road accidents.

Climatic conditions are the air temperature, humidity, air flow and air pressure.

Pleasant climate in the car keeps the driver in good condition and ready, even during long journeys. Good heating, ventilation and air conditioning are important for supporting high standards of vehicle safety.

Perceptual safety – the level of safety which increases the perceptual security, focuses on lighting equipment, audio warning devices, direct and indirect view of a vehicle.

Operator safety – relaxed driver (driving without stress), as well a high level of driving safety, requires an optimal design for the driver's surroundings with respect to its comfort.

Safety and comfort are interlinked in many aspects. Driver who sits comfortably, has a good posture and easy to read, easy to understand and reach ergonomic devices and controls, can better manage and better concentrate on the surrounding traffic conditions. The driveline has also an important role. A vehicle that provides good management capacity in terms of electronic engine management, or even automatic transmission, puts less stress on the driver.

Overview of active safety:

- ABS (Anti-lock Braking System) – anti-lock brakes, prevents the wheels from locking while braking and allows the driver to maintain control of the vehicle;
- ADM (Automatic Dimming Mirror) – auto darkening mirror; prevents glare in the rearview mirror caused by the lights from the moving vehicle behind;
- ALC (Adaptive light control) – allows to adjust the orientation of the beam according to driver's needs, for example in urban areas may be more useful if the light beam's orientation is wider, while on the highway longer. The orientation of the reflectors is managed by bending and the slope of the road;
- BAS (Brake Assistance System) – braking assistant, in critical situations and when the ABS regulates brake pressure, brake pedal may begin to vibrate, which can cause the driver to release the pedal to prevent these vibrations, which however reduces the effectiveness of braking;
- ASR (Anti-Slip Regulation) – prevents wheel-spin and changing direction on acceleration;
- RDC – tyre pressure control system,
- EBD (Electronic Brake-force Distribution) – distribution of the electronic brake power optimally between front and rear axles;
- ESP (Electronic stability program) – is improving the driving control and automatically stabilizes the vehicle in all situations;
- Intelligent suspension – automatically adjusts ride height according to speed and road conditions;
- Power Steering – reduces the power required to operate the vehicle, therefore making the control of vehicle easier;
- HUD (Hheads-Up Display) – visualization of data relevant to the driver in the driver's vision angle;
- Night Vision – uses an infrared camera and the image is projected on the HUD display, hence allows better management at night and in bad weather conditions;
- Signaling of incorrectly closed door;
- TCS (Traction control System) – a system that prevents wheel overspin and allows the driver to maintain control of the vehicle, it controls engine power and sometimes braking system;
- VARILIS (Variable Intelligent Lighting System) – a flexible intelligent lighting system that uses fiber optics and is able to change the characteristics of the light beam immediately;
- Xenon headlight – bulb that generates light due to the electric arc, its power is larger than the one of conventional halogen lamps;
- RFT (Run Flat tyre) – type of tyre, which allows to drive to safety with a puncture; different tyre manufacturers use their own names for this technology, etc.

Passive safety of vehicles

Passive safety includes all the features and measures in the vehicle that minimize the consequences of an accident or prevent it. Passive safety is especially important when the driver cannot actively intervene in the affairs of the road anymore.

Passive safety can be divided into external (exterior security) and internal (interior security).

External safety – the term passive safety includes all actions associated with the vehicle which are useful in minimizing injuries in road traffic collisions and outside the vehicle (pedestrians, cyclists). Factors that determine the external safety are the behavior of the car body during deformation, and the external shape of the car body.

Internal security – is the protection of the vehicle by those kind of measures that are minimizing the acceleration and initial internal forces on the passengers in the event of an accident, and also provide enough space for survival and ensure the operability of the critical components of the vehicle to rescue passengers from the vehicle.

Important for passenger safety are:

- the behavior of the car body during deformation;
- strength of the passenger compartment and a large living space during accidents;
- restraints;
- deceleration systems;
- bump in the interior;
- control systems;
- deliverance of passengers;
- fire protection, etc.

Passive safety features overview:

- Airbags (front, window, side, knee, front to rear passengers) – prevent the collision of the body, respectively individual body parts of the steering wheel, instrument panel and other interior parts of the vehicle absorb shock and reduce the risk of injury;
- Active head restraints – in case of an accident they are moving forward and upwards thus reducing the risk of neck injuries;
- Anti-slip passenger system – prevents slipping of the pelvic area from the seat in the event of a frontal collision;
- Safety belts – prevent sudden movement of the body in the accident;
- Safety features of the vehicle structure – are increasing the firmness of the car body in the event of collision by creating zones with progressive deformation and absorption capacity (Fig. 1);
- Collapsible steering column – in case of an accident it reduces the driver's risk of hitting the steering wheel;
- Child lock – prevents opening the car door from inside;
- Electric lock with automatic locking;
- Parking Assist – Audio signaling when reversing towards obstacles;
- FPS (Fire Protection System Safety) – a system which blocks the supply of electricity and fuel in case of an accident, to avoid the risk of fire;
- System for avoiding of wedging of a small car – is used in trucks to reduce the risk of wedging of a small passenger car in a frontal collision;
- Announcement of a traffic accident (eCall), etc.

Approval of vehicles

There are the two main parallel systems of regulatory acts in the field of vehicle approval and a new system of global technical regulations.

The first group consists of the Geneva regulations issued under the 1958 Agreement (Agreement concerning the adoption of uniform conditions of approval (verification of identity) and reciprocal recognition of approval for equipment and components for motor vehicles concluded March 20, 1958 in Geneva. The Decree of the Minister of Foreign Affairs no 176/1960 ECR). The agreement provides only the framework conditions. Specific regulatory acts are solved by individual UNECE, which formally annexed to the Agreement. The former Czechoslovakia signed the agreement in 1960 as the eighth state. The agreement does not bind the parties to the mandatory application of all or specific regulations of the UNECE. The use of every regulation of the UNECE shall the member states first notify. The Member state of the agreement, that notified the regulation, is obliged by the agreement to recognize approvals under this Regulation granted by other states and should not subject such laws or create obstacles for the adoption and introduction into service of approved vehicles or their parts. A member state of the agreement, that has notified the use of certain rules therefore does not have to, but may apply these regulations within its territory or some of them as required. This is a national matter for each state. This system allows only partial approval pursuant to various regulations – regulatory acts.

The second group are the EU rules accepted in the form of EC/EEC directives, and now also in the

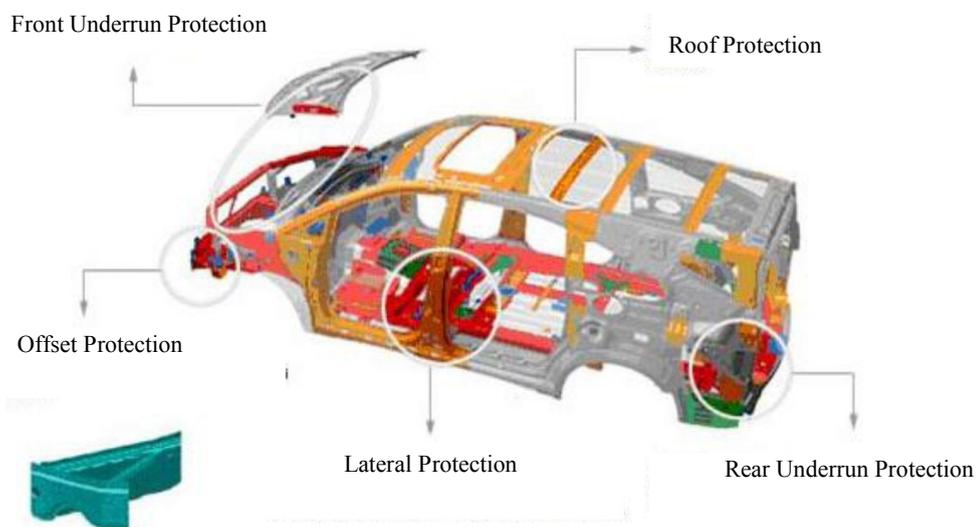


Fig. 1. The safety features of the vehicle structure [1]

form of EU/EC/EEC regulations. These regulatory instruments are binding for all Member States. In some cases, they are parallel to the UNECE regulations, in some cases they are separate regulatory acts. This system allows approval of the entire vehicle by meeting all regulatory acts.

The third group consists of global technical regulations (GTR) issued under the 1998 Agreement (Agreement concerning the establishing of global technical regulations for wheeled vehicles, equipment and parts which can be fitted or used on wheeled vehicles. Notification of the Ministry of Foreign Affairs of the Slovak Republic no 415/2003). Like the UNECE regulations, the global technical regulations are also mandatory for member states as long as the individual states are transforming them into their national legislation. In the European Union these rules have to be transformed by the EU regulatory acts (second group) in the form of EC/EEC directives or regulations of the EU/EC/EEC.

Prior entering the EU, the Slovak Republic was following only the regulatory acts only the first group. As for the third group, the Slovak Republic was a member of the agreement, but did not apply any of the global technical regulation. After joining the EU, the regulatory acts of the other groups became mandatory for the Slovak Republic. Currently, in accordance with the recommendations of the CARS 21 report some partial regulatory acts of the EU (separate directives) will be replaced by the UNECE regulations. Vehicle manufacturers will be able to reduce their administrative burden.

In the next section, I will discuss only the second group – the technical requirements under the EU regulatory acts.

Technical requirements for vehicles

The relevant regulatory acts are setting the technical requirements for vehicles. When approving the vehicle for operation on the road, each vehicle must meet all the technical requirements established by regulatory acts. The approval of vehicles is regulated by the regulations of the European Union concerning the construction of vehicles, which can be divided into three groups:

- 1) motor vehicles and their trailers (category M, N and O);
- 2) motorcycles, trikes and quads (category L);
- 3) wheeled agricultural and forestry tractors (category T).

Figure 2 is a schematic division approval of vehicles between three basic framework directives.

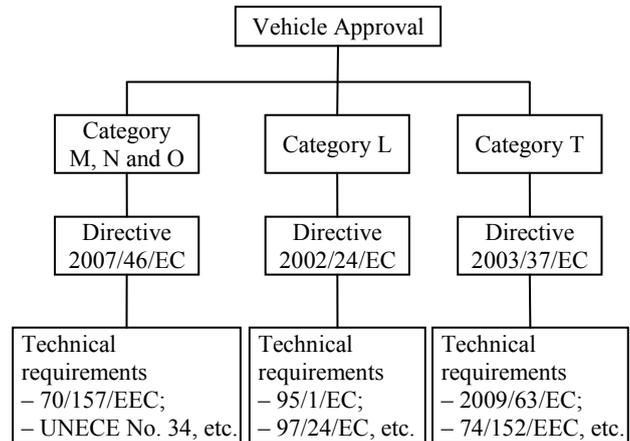


Fig. 2. Schematic of vehicle approval [own study]

Technical requirements for vehicles can be classified as:

1. technical requirements of active safety, which include:
 - braking;
 - steering effort;
 - an audio alarm;
 - tyre assembly;
 - front view;
 - defrosting and demisting of the windscreen;
 - devices for indirect vision (mirrors);
 - speedometer and reverse gear;
 - wiper and windscreen washer;
 - connecting devices;
 - etc.;
2. technical requirements for passive safety, which include:
 - frontal collisions;
 - side collision;
 - anchor tabs seat belts;
 - ISOFIX anchorages systems;
 - safety belts and restraint systems;
 - seats and their anchorages;
 - head restraints;
 - vehicle interior equipment;
 - access to vehicles;
 - vehicle maneuverability;
 - locks doors;
 - external projections;
 - pedestrian protection;
 - wheel covers;
 - rear protective equipment;
 - fuel tanks;
 - protection of the driver against the steering mechanism;
 - safety glazing;
 - handles for passengers, etc.;

3. technical requirements of the environment, which include:
 - emissions (EURO 5 and EURO 6 or EURO V and EURO VI);
 - noise;
 - recyclability;
 - electromagnetic compatibility;
 - air conditioning systems, etc.;
4. other technical requirements, which include:
 - the installation of lighting and light-signaling devices;
 - place for the rear registration plate;
 - weights and dimensions;
 - location and identification of controls;
 - tell-tales and indicators;
 - towing devices;
 - protection against unauthorized use;
 - heating systems;
 - engine performance;
 - data plate and VIN;
 - hydrogen system;
 - general safety;
 - gear shift indicators;
 - alarms;
 - electrical safety;
 - LPG;
 - CNG, etc.

Conclusions

Several industry more vehicle manufacturers are investing considerable funds in developing new safety systems which aim to prevent the accident as a negative phenomenon of the road, or in case of an accident to eliminate the consequences of an accident. Currently, new technologies are available that can dramatically improve vehicle safety (such as electronic stability control) or reduce CO₂ emissions (such as tyres with low rolling resistance). Conventional vehicles are not equipped with all known safety features that are available on the market, because of their higher price. Vehicle manufacturers typically fit the latest safety features into the highest classes of vehicles manufactured, but over time these elements are becoming almost routine feature of lower vehicles classes too.

Research has indicated that the introduction of such technologies as standard on new vehicles would bring significant benefits for the road safety. These new security technologies are already invented. Features, such as Electronic Stability Control Systems are already appearing within some markets on an increasing number of vehicles. The electronic stability control systems would be even

more beneficial on vehicles, such as heavy trucks and tourist coaches than by passenger cars. Often, there is no incentive on the market which would make the manufacturers voluntary install the electronic stability control systems, since buyers usually are not the ones who benefit from it.

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