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MOBILTECH TYPE TECHNICAL TEXTILES – PROTECTION AND SAFETY SYSTEMS OF A VEHICLE

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Abstract: *Lately the textile industry has undergone revolutionary changes with some of the most remarkable innovations. These have led to the expansion of high-performance technical textiles, with multifunctional destinations, of those with special properties considered passive systems, and of products that "feel" and react to external stimuli of a different nature like mechanical, thermal, chemical, magnetic and so on. The Mobiltech branch represents the most important field of technical textile applications, accounting for approximately 20% of the total production volume.*
The protection and safety systems of a motor vehicle include both the equipment aimed at avoiding an accident and those intended to save the life of the passengers in the event of a crash. These equipments underwent essential developments, aimed at ensuring and improving the protection and safety of vehicle passengers against impact and / or injury in the event of a collision, timely detection of accidents, continuous monitoring of traffic and early diagnosis of possible damage or defects, production of airbags with pre-determined dimensions and capacities dependant on their end-use, increasing reliability, reducing manufacturing costs, etc. Taking into account the structure of the protection and safety systems of a vehicle, this paper presents the main aspects to be kept in sight during manufacture and improvement of airbags and seatbelts, characterisation of the main types of seatbelts, quality features and requirements of the passive protection systems, as well as the current development trends of these Mobiltech products.

Key words: *protection, safety, automobiles, textile, seatbelts, airbags.*

1. GENERAL CONDITIONS REGARDING THE PROTECTION AND SAFETY SYSTEMS OF A VEHICLE

Lately the Textile industry has undergone revolutionary changes with some of the most remarkable innovations. These have led to the develepoment of high-performance technical textiles, with multifunctional destinations, of those with special properties considered passive systems, and of products that "feel" and react to external stimuli of a mechanical, thermal, chemical, magnetic and so on nature. Manufactured for their technical performance and their functional properties, technical textiles meet the high technical-qualitative requirements and can adapt to a variety of destinations.

The Mobiltech branch represents the most important field of applications for technical textiles, amounting to about 20% of the total production volume. The percentage of textile materials used in a vehicle is about 2.2% of its total weight [1, 2].

The protection and safety systems of a vehicle can be classiffied as [3, 4]:

- **Active collision avoidance systems):** braking systems, lateral and rear-view mirrors, headlights, break lights, floodlights and signal lights, tyres.
- **Active collision avoidance systems:** systems that do not allow brake locking - ABS (Antiblockiersystem); ESP Electronic Stability Program (ESP); infrared system (allows to capture images at night); adaptive headlights; parking sensors and cameras to assist side and rear view parking; lane change assist and blind spot detection; tire pressure sensors; TCS (Traction Control System); automatic braking on slope or parking lots; autopilot with speed radar; automatic braking force distribution; Precrash systems; emergency braking assistance.
- **Passive protection and safety systems in case of collision:** seat belt and airbags; crumple zones in case of impact; front, side and rear bumpers; safety cell (on Smart cars); rigid or secured windows; passenger protection systems in the cabin
- **Post-impact assistance systems** automatic phone call to intervention services; pyrotechnic staples for the automatic opening of the doors in case of overturning or sinking.

2. PASSIVE PROTECTION AND SAFETY SYSTEMS IN CASE OF IMPACT

The seat belt and airbag operate in tandem in regards to the protection offered. In case of impact, the seat belts restrain the driver / passengers, while the airbag protects them against collision with the steering wheel, the dashboard or the other hard surfaces inside the vehicle. The airbag is automatically triggered in the event of a collision between two or more vehicles and has been continuously improved, so that depending on the weight of the occupant and the severity of the impact, it can be opened in several stages with various intensities [5].

2.1 Seat belts

The **seat belt** is a unit made of straps with a safety buckle, adjusting devices and fastening pieces, which can be anchored inside a vehicle and is designed to reduce the risk of injury for the passenger in the event of a collision, or sudden braking of the vehicle, limiting the passenger's body mobility. Such an ensemble is generally referred to as a "belt", a term which also includes any energy absorption or retraction device [6]. Safety belts are defines as primary restraint systems (PRS) because of their vital role in passenger safety.

Seatbelts can be of various types, differing substantially from one another by their rigid components, flexible component (strap), or the belt geometry [6]. The main types of seat belts, classified using the number of attachment points (fastening) are presented, illustrated and characterized in tables 1, 2, 3, 4, 5, 6.

Table 1 *Two-point seatbelts*

Characteristics	**Image** [1]
✓ The two-point seat belt can be: **abdominal belt** (passes over the front of the pelvic region of the passenger), or **diagonal belt** (passes diagonally in front of the chest, from the hip to the opposite shoulder) [5]; ✓ The two-point seat belt was first used in March 1910 by pilot Benjamin Foulois; ✓ Usually these types of belts are used in aircrafts for passengers and coaches; Unlike road vehicles, seatbelts for aircraft have been designed with the purpose of restraining passengers during turbulence [6]; ✓ James Crash (Univ. Minnesota), invented the retractable seat belt.	

Table 2 *Three-point seatbelts*

Characteristics	Images
✓ It is a combination between the transverse belt and the diagonal belt; ✓ The three-point seat belt was developed in its modern form, by the Swedish inventor Nils Bohlin for Volvo - which introduced it in 1959 as standard equipment; ✓ In the current stage, all vehicles use adjustable seatbelts, with 3-point attachments; The 3-point retractable belt is locked in the event of a sudden tension; ✓ In case of an increased risk of accident (skidding, loss of control), on Mercedes S-class cars, the **Pre-Safe system** automatically tightens the seat belt and locks it [3]	

Table 3 *Airbag safety belts*

Characteristics	Image
✓ In all modern vehicles equipped with airbags, the seat belt activates the airbag. An unfastened seatbelt could cause airbag malfunction [3]. The reason is obvious: in case of impact, if the passenger is not held by the seat belt, it will be propelled toward the airbag, with a force that could break the spine. When the belt is fastened, only the head will come in contact with the airbag, thus attenuating the impact [3]; ✓ Studies have shown that seatbelts associated with airbags reduce the accident rate by about half [7].	

Table 4 *Seatbelts with 4, 5 and 6 points*

Characteristics	Images
✓ 5-point seat belts (two shoulder belts, an abdominal one and another between the thighs, connected to it) are usually used in child safety seats and racing cars; ✓ 4-point belts are similar, but without the thigh belt; ✓ belts with 6 attachment points have two additional belts between the thighs; ✓ 5 or 6 point belts are used in motor sports, along with racing seats. The belt consists of 2 straps over the shoulders, two side pieces and 1 or 2 thigh straps, all connected in the abdominal area; ✓ The fastening of these belts is very precise and, unlike the retracting belt, it is fixed and does not allow very wide movements of the body. It is a very safe system, especially in case of overturning the car. [8].	  

Table 5 *Inflatable safety belts*

Characteristics	Image
✓ The inflatable seatbelt was invented by Donald Lewis; ✓ Inflatable safety belts have tubular inflatable compartments, contained in the outer cover [6]; ✓ In the event of an accident, these compartments swell, increasing the restrain zone that comes into contact with the occupant, as well as tightening the belt around him, improving protection; ✓ Inflatable sections can be present on the shoulder, abdominal area, or both; ✓ The system offers both head and trunk protection.	

Table 6 *Automatic seatbelts*

Characteristics	**Image** [7]
✓ In the United States, automatic seatbelts have been implemented which move and affix themselves to a passenger's body, once the doors are closed and/or the engine is running. ✓ They were developed as a countermeasure against the low rates of use for manual seat belts; ✓ The usefulness of the system has not been demonstrated, being more of a comfort option than one of increasing security, seeing as the system can be deactivated or modified.	

2.2 Airbags

Airbags are safety devices for vehicles consisting of pillows, made of thin and durable materials, recessed in the steering wheel, dashboard or seats and which, in the event of an impact (collisions) swell instantly, protecting the car occupants [9].

These passenger safety equipments are electronically controlled and are also known as **Supplemental Restraint System (SRS)**. In case of collision, the airbag automatically activates, a pyrotechnic charge filling with nitrogen gas (almost instantly) a special cushion of flexible material, in order to protect the **occupants** of the vehicle from possible contusions and / or injuries with the hard objects inside it. [9].

Aibags can be classified using multiple criteria [1], like: airbag type, number of passangers protected, destination, placement, impact type, fixing module, material used in manufacture and the type of finishing applied to the material.

According to their type, airbags can be:

- Interior airbags for the passengers – figures 1, 2, 3 [1];
- Exterior airbags for the pedestrians – figure 4;
- Exterior partial airbags for the vehicle – figure 5;
- Exterior airbags for the whole vehicle – figure 6.

Fig. 1 *Frontal interior airbags*

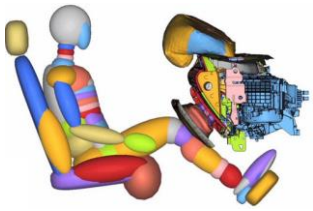

Fig. 2 *Interior airbags for knees*

Fig. 3 *Panoramic or curtain airbags*

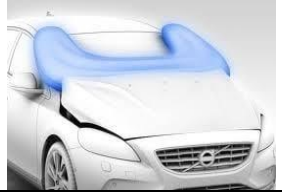

Fig. 4 *Exterior airbags for pedestrians*

Fig. 5 *Exterior partial airbags for the vehicle*

Fig. 6 *Exterior airbags for the vehicle*

3. GENERAL QUALITY REQUIREMENTS AND CHARACTERISTICS FOR PROTECTION AND SAFETY SYSTEMS

In accordance to the purpose for which they were created, the main requirements and functions of these safety products are:

- ✓ Ensuring and improving the protection and safety of passengers of the vehicle against collision and / or injuries caused by the hard surfaces inside it (steering wheel, dashboard, windshield, bonnet, rear window, doors, etc.), in the event of a vehicular accident;
- ✓ Correct and timely detection by the sensors of impact, speed, braking, position, weight and safety (collisions) and of the hazard warning signals;
- ✓ Quickly run-through of self-diagnosis for the entire protection and safety system;
- ✓ Appropriate tensioning of the seat belts to prevent impact / injury of the passengers;
- ✓ Airbag inflation under controlled speed (approximately 200 - 300 km / h [10, 11]) and in the expected time (it is recommended that full inflation should be achieved in about 0.03 seconds from impact [10]);
- ✓ Recording the errors of the car's computer memory and activating the hazard lamps;
- ✓ Reduction of manufacturing costs.

3.1 Quality requirements for the components of a seat belt

The most important quality features for the components of seatbelts are presented in table 7:

Table 7. *Quality requirements for the components of a safety belt*

Quality requirements for rigid belt components	**Quality requirements for the strap of a safety belt [**5, 2, 12]
❖ all rigid elements of the seat belt must be perfectly smooth and not have sharp protuberances, which could cause wear or tear of the belts through rubbing;	❖ adherence to geometric dimensions of the strap (width ≈ 50 mm, length ≈ 9 - 10 m);
❖ must be properly protected against corrosion and abrasion for all components of the belt;	❖ the pressure exerted by the strap on the passanger's body must be evenly distributed over its width;
❖ buckle inspection, testing its resistance, as well as testing the opening of the buckles in different situations, including at low or high temperatures;	❖ the width of the strap, under a load of 980 ÷ 1000 daN, must not be below 46 mm;
❖ fixing system inspection;	❖ the strap should not twist under tension;
❖ carrying out functioning tests for the retractors;	❖ strengthening and finising the edges of the strap.
	❖ the breaking load of the strap must be at least 1 470 daN;
	❖ high resistance to abrasion, temperature changes, chemicals, fungi and microorganisms;
	❖ high light resistance;
	❖ low moisture absoption capacity and rapid drying;
	❖ reduced combustion capacity;
	❖ the forward movement of the passenger, the strap allows, must be between: - 80 - 200 mm at the pelvic level in the case of transverse belts; - 100 - 300 mm at chest level; - in a harness type belt, the minimum displacements can be reduced by half.

4. CONCLUSIONS

The continuous diversification of beneficiary requirements in the automobile industry, with regards to the protection and safety of the traffic participants, has led to the emergence of the most remarkable innovations to the **Supplemental Restraint System (SRS**). These innovations include the development of **intelligent restraint systems** that adapt to the geometry of the passenger compartment, position and height of the seats, passenger type and weight (adults, children) and severity of collision, etc.

As the number of vehicles is constantly increasing, and at the same time becoming even faster, protection and safety systems in cars have undergone essential developments during the last 100 years, which have been aimed at:

- ✓ ensuring and raising the level of protection and safety for passengers in a vehicle against hits and / or injuries in the event of a collision;
- ✓ continuously monitoring the traffic and timely diagnosis of possible damage or accidents;
- ✓ improving systems that rely on satellite and internet;
- ✓ implementing systems that allow cars to visualize each other in traffic or in the middle of intersections;
- ✓ creating seatbelts, high-performance airbags and systems, capable of protecting the passengers as much as possible;
- ✓ increasing reliability, reducing manufacturing costs, etc.

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