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Defensive Driving a Motor Vehicles: Case Studies

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Abstract

This scientific paper presents the authors' own point of view on defensive driving, in which eight case studies are analysed and discussed. It is a continuation of the scientific paper titled “*The Role, Place, and Importance of Preventive-Defensive Driving in Avoiding Traffic Accidents*”, a scientific study published by the same authors in Advanced Multidisciplinary Research and Studies (IJAMRS), ([https://www.multiresearchjournal.com/arclist/list-](https://www.multiresearchjournal.com/arclist/list-2026.6.4/id-6796)

2026.6.4/id-6796), Volume 6, Issue 4 July - August 2026 pp. 1682-1693, ISSN: 2583-049X; DOI: <https://doi.org/10.62225/2583049X.2026.6.4.6796>. At the end of the scientific paper, conclusions are drawn regarding the domain addressed. To conduct this scientific research, experts in defensive driving were consulted, videos were watched, books, websites, and specialized journals were reviewed.

Keywords: Defensive Driving, Vehicle Speed, Reserve Plan, Accelerator Pedal, Safety Belt, Vehicle Headlights, Cabin Lights, Summer/Winter Tires

1. Introduction

Road safety is a vital aspect of any society, and achieving positive results depends on factors such as road conditions, vehicle technical compliance, and driver behavior on the road. As a result of efforts in this direction, a new concept known as defensive driving has been developed, which is based on the driver's proactive attitude ^[1]. Through these practices, drivers must not only respond to circumstances but also anticipate the dangers around them in order to prevent accidents. Defensive driving, by definition, is characterized by an awareness of the existence of unforeseen risks that cannot be properly addressed through reactive driving. Therefore, it is necessary to take measures that offer the possibility of ongoing training to ensure an appropriate response should problematic situations arise. This last aspect can have a beneficial effect in terms of avoiding problematic situations. Defensive driving is driving a car in a preventive manner that allows drivers to learn certain techniques through which they can prevent traffic accidents and anticipate imminent dangers on the road. In other words, defensive driving is a safe driving style that helps drivers become aware of and identify traffic risks and prevent various unexpected situations. Defensive driving refers to drivers who prioritize road safety when they get behind the wheel so as not to endanger their own lives or those of others, regardless of road conditions, weather, or the actions of other road users ^[2]. One of the basic components of defensive driving is following the basic rules of the road, namely driving within the speed limit and obeying traffic signs so as not to endanger other road users.

2. Literature review and legislation

2.1 Literature Review

Prevention means taking steps in advance to avoid an unfortunate event, damage, or illness. The term also refers to the act of warning or informing someone in advance about a potential situation.

- **Avoiding a danger:** Taking precautions to prevent an accident, a conflict, or an undesirable situation (e.g., *preventing a fire*);

Here are the main contexts in which this term is used:

- **Health and medicine:** Taking action to stop the onset or worsening of a disease, a process also known as prophylaxis (e.g., preventing a cold through vaccination);

- **Information / warning:** Drawing someone's attention to negative consequences or a future event (e.g., I'm warning you that it will rain tomorrow).

According to the explanatory dictionary of the Romanian language, the adjective "*preventive*" refers to actions intended to forestall harm or prevent the onset of a disease and other problems. In a general sense, the word "*preventive*" means those measures taken in advance to avoid an unpleasant situation or a danger ^[3].

2.2 Legislation

At the European Union level, there is no single set of traffic laws, but road safety and defensive driving are regulated through complex directives and strategies. The guiding framework is the EU Road Safety Policy Framework 2021–2030, which aims for "*Vision Zero*" (zero road deaths by 2050) ^[4].

Preventive driving is incorporated into European legislation through three main pillars:

A. The Directive on Driving Licenses

European regulations on driver's licenses and testing explicitly include elements of defensive driving ^[5].

- **Beginner drivers:** Driver's education courses and exams require candidates to demonstrate knowledge of hazard anticipation, proper reaction behind the wheel, and heightened attention to vulnerable road users (pedestrians, cyclists);
- **Renewal and testing:** The European Directive standardizes medical examination processes and enhances training for both private and professional drivers ^[6].

B. Mandatory safety equipment (ADAS systems)

Preventive driving behavior is actively supported and technologically enforced through vehicle certification standards. New cars must be equipped as standard with advanced driver-assistance systems (ADAS), which help prevent accidents:

- Automatic emergency braking (AEB);
- Intelligent Speed Assistance (ISA—warns and limits speed based on road speed limits);
- Lane-keeping systems and lane departure warning;
- Driver fatigue and inattention detection.

C. Road Infrastructure Management and Safety

Defensive driving is not just a matter for the driver, but also depends on how the road is designed. Directive 2008/96/EC ^[7], on road infrastructure safety requires Member States to conduct periodic risk assessments, safety audits on road networks, and to implement standardized road markings and signage to facilitate the anticipation and prevention of traffic dangers.

In Romania, traffic laws define defensive driving as a driver's behavior that prevents accidents by anticipating risky situations and adjusting speed to road conditions. This is primarily regulated by Government Emergency Ordinance (GEO) 195/2002 on traffic on public roads ^[8] and its implementing regulation ^[9].

3. Defensive driving car: Case Studies

3.1 What is the appropriate speed for driving safely on a public road or highway when practicing defensive driving?

According to regulations and the relevant research literature, the appropriate speed for safe driving is not a fixed number, but rather a speed that is constantly adapted to road, traffic, and weather conditions. The Romanian Highway Code

specifies: the speed at which you travel on a public road or highway must allow you to perform any maneuver safely.

Here are the general rules and recommendations from both Europe and Romania for safe driving in 2026:

A. The legal speed limits (under ideal conditions) for vehicles in categories A and B (motorcycles and passenger cars) are as follows:

- **Built-up areas:** Maximum 50 km/h; in residential areas or areas with heavy traffic, lower speeds are recommended (30 km/h). In residential areas or areas with heavy traffic, lower speeds are recommended;
- **Expressways:** Maximum 120 km/h;
- **European national roads (E):** Maximum 100 km/h;
- **National roads:** 90 km/h;
- **Highways:** Maximum 130 km/h.

Note: Speed limits may vary depending on the EU country you are in, as traffic laws are specific to each member state.

B. Speed based on conditions (practical safety): You must reduce your speed below the legal limit in the following situations:

- **Reduced visibility (fog, heavy rain, snowfall):** Under 50 km/h outside built-up areas and under 30 km/h within built-up areas (when visibility is less than 100 m);
- **Roads covered with snow, ice, or sleet:** A reduced speed is recommended, adjusted to prevent skidding;
- **Dangerous curves, uncontrolled intersections, or congested areas:** Speed must allow for a safe stop.

C. The rule of safe distance: Safety depends not only on speed, but also on the distance from the vehicle ahead. The general rule is to maintain a distance that allows you to stop safely. A practical rule of thumb is the 2-second rule on dry roads (the rule was presented in Chapter 4 of this scientific study), which should be doubled on wet roads.

Recommendations from the authors for safe driving, thus:

- **Anticipate:** Watch the traffic ahead of you, not just the car directly in front;
- **Don't follow others:** Just because other drivers are speeding doesn't mean it's safe;
- **The vehicle's technical condition:** Make sure your tires and brakes are in good working order.

Many drivers, even experienced ones, do not know exactly what the appropriate speed is—the correct speed at which they should be driving on public roads. As we mentioned earlier, the answer, unfortunately or fortunately, is not a number.

There is no universally accepted standard speed. Most drivers choose their speed based on what appear to be ideal conditions (clear road, good visibility, normal traffic flow). In this context, it can feel as though you can increase the speed of the vehicle you are driving because nothing bad can happen.

The problem is that traffic situations don't become dangerous the moment we notice them. They become dangerous when they occur suddenly (e.g., a child or a careless person may step into the roadway from between parked vehicles; a vehicle may brake in front of us for no apparent reason; a driver may change lanes while moving without checking).

If the speed at which we drive is determined solely by current conditions, without taking into account what might happen when an unexpected situation arises, we won't have enough time to react.

Preventive-defensive driving means exactly the opposite. It means choosing a speed not for when everything is fine, but for when something goes wrong, when things aren't right. This aspect involves looking beyond what is obvious, observing high-risk areas, parked vehicles, crosswalks, intersections, congested areas, or situations where visibility is limited.

In all these cases, the speed we've adjusted to must give us a significant advantage: *reaction time*. In this case, the braking distance is not the main issue, but rather the time it takes for us to begin reacting, and that time depends directly on our speed. The higher the speed, the shorter the distance and time until a collision with an obstacle on the road, and our margin of safety disappears.

It is important to note that braking distance increases exponentially with speed and is directly influenced by reaction time (the time between when the driver notices an obstacle on the road and when they press the brake pedal). If the road surface is wet, the braking distance increases due to the reduced grip of the tire on the road surface. Fig 1 illustrates the relationship between the driver's reaction time, braking distance, and stopping distance of the vehicle under the 3-second rule. The figure also shows the minimum recommended distance under the 3-second rule (indicated in grayscale on the graph).

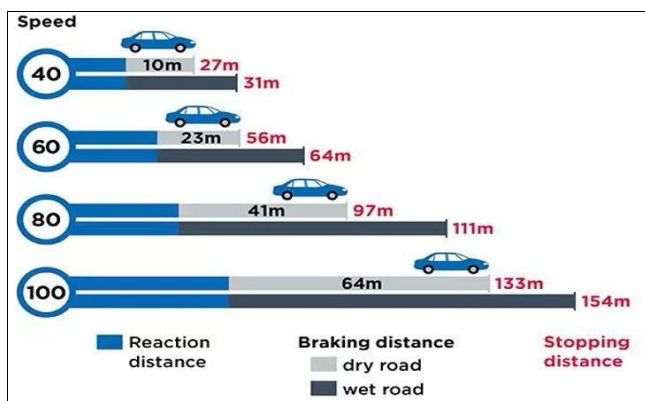


Fig 1: The relationship between the driver's reaction time, braking distance, and stopping distance of the vehicle under the 3 - second rule

The 130 km/h speed limit on the highway is not a requirement; it is a limit. Most drivers misunderstand this and end up believing that they must drive at 130 km/h to keep up with the flow of traffic on the highway.

The reality is that the maximum speed limit does not mean the recommended speed, much less the mandatory speed. It is simply the threshold we should not exceed under ideal conditions. Equally important is the fact that there is no minimum speed that must be observed when driving on a highway, which would require us to drive at a slower pace. In this regard, traffic laws specify that: we are not permitted to drive on the highway in vehicles that, by design, cannot reach at least 50 km/h. This provision refers to the mandatory minimum speed a vehicle can reach, not to the obligation to maintain a specific speed constantly; however, the fact that it complies with legal requirements does not necessarily mean it is safe. At low speeds on highways, the speed difference between such vehicles and the rest of the traffic (130 km/h) is enormous, and this increases the risk. A vehicle traveling at 50 km/h on a highway, even if it is in the

far-left lane, becomes a dangerous obstacle for other vehicles traveling at higher speeds.

In this case, defensive driving means choosing a speed that is not only legal but also allows us to fit safely within the flow of traffic. If 110 km/h is the speed that ensures our safety and comfort on the highway and allows us to anticipate any danger in time, then that is the right speed for driving safely.

The problem arises when drivers start pushing themselves to go faster than they can handle, just because that's how people drive on the highway.

A common example is passing in the second lane. Many drivers begin to pass and accelerate up to 130 km/h, or even faster, simply because they feel that "*that's how it's done*". If we lack control and comfort at that speed, we should not attempt to pass, because the moment an unforeseen situation arises (a vehicle braking suddenly, a slower speed of another vehicle ahead that we could not estimate or anticipate, a delayed reaction on our part), we no longer have the ability to properly handle the situation that has arisen.

On the other hand, it's perfectly normal to be annoyed by a driver in traffic who is passing in the second lane at 110 km/h while we're coming up behind them in the same lane at a much higher speed. The annoyance can be mutual. In this case, the speed difference is significant, and the feeling of being "*stuck*" sets in instantly. This is where the responsibility of each of us comes into play, in our capacity as drivers: the one who overtakes by moving into the second or third lane must ensure that the maneuver is performed safely and within a reasonable time and space, and those approaching at higher speeds from behind in the same lane must understand that not all road users are traveling at the same speed and that these differences must be managed, not forced. At high speeds, seemingly small differences in speed mean rapid closing of the gap and loss of space in a short time. For this reason, we should not adapt to the speed of others, but rather adjust our vehicle's speed to our actual level of control and properly manage the differences between ourselves and other vehicles on the road.

It is much safer to drive at a constant, predictable, and controlled speed than to alternate between sudden accelerations and moments of uncertainty.

Defensive driving corrects inappropriate speed through anticipation and proactive adaptation, transforming speed from a risk factor into a tool for control.

Here's how this driving style addresses speed that is not adapted to traffic conditions:

- **Avoid speeding:** A defensive driver does not simply adhere to the legal speed limit, but reduces speed below it whenever conditions (poor visibility, wet roads, heavy traffic) require it;
- **Increase your following distance:** By reducing speed, the stopping distance decreases significantly, and the distance between vehicles increases. The "3-second rule" (or longer in adverse weather conditions) is frequently applied to avoid rear-end collisions;
- **Prevent loss of control:** Adjusting your speed before turns or areas with low traction prevents skidding and loss of steering control;
- **Increase reaction time:** A reduced and appropriate speed gives the driver the extra time needed to notice pedestrians or the unpredictable maneuvers of other road users and to react correctly;

- **Reduce the severity of an impact:** If an accident becomes unavoidable, a reduced speed drastically reduces the kinetic energy dissipated, minimizing property damage and the risk of serious injury.

3.2 The Reserve Plan (Plan B) in defensive driving

The Reserve Plan in preventive-defensive driving (often referred to as "*Plan B*" or the "*escape rule*") involves anticipating a dangerous situation and preparing an alternative course of action to avoid a traffic accident should the risk materialize.

This concept is based on the premise that you **cannot control the actions of other road users**, but you can control how you react.

The key components of an Reserve Plan are:

A. Anticipation and scanning (preparation):

- A preventive and defensive driver scans the road ahead (10–15 seconds ahead) to identify potential hazards (pedestrians, cars braking suddenly, black ice);
- **Action:** If we notice a vehicle stopped on the side of the road, our backup plan is to slow down and move into another lane, even if it doesn't appear to be coming into our path;

B. The 3-second rule (safety distance):

- Maintaining a safe following distance allows for reaction time and an escape route;
- **Action:** If the vehicle in front brakes suddenly, the backup plan is to ensure there is enough space to stop safely or swerve into an open area (shoulder, adjacent lane).

The 3-second rule is a simple and effective way to maintain a safe following distance from the vehicle ahead, allowing enough time to react and stop safely (Fig 2). In adverse weather conditions (rain, fog, snow) or on unpaved roads, we recommend increasing this distance to 4–5 seconds.

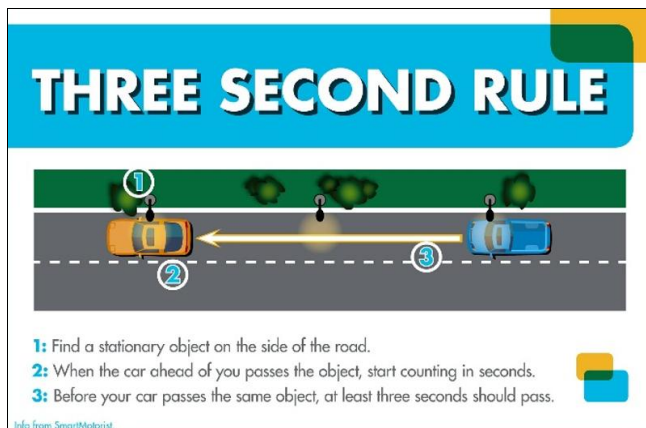


Fig 2: The 3-second rule in defensive driving

C. Identify the evacuation route (escape route):

We must always keep an "escape route" in mind in case the situation ahead becomes critical;

- **Action:** When driving, ask yourself: "Where will we go if the vehicle in front brakes and stops suddenly?" The answer might be: "to the right shoulder" or "to the left lane, if it's clear."

D. Adapting to traffic or road conditions:

- If visibility is poor or the road is wet, the backup plan is to reduce your speed below the legal limit to maintain proper control of the vehicle. In Table 1 we presents an example of a "Plan B"

Table 1: Practical examples of a "Plan B"

Risk situation	Reserve Plan/B Plan (preventive-defensive action)
You're driving behind a truck	Increase the following distance to 5–6 seconds so you can see what's ahead and have enough time to brake
The vehicle is coming from the opposite direction and is driving in the wrong lane	Slow down and move to the right shoulder
Children are playing with a ball on the side of the road or in the vicinity.	Slow down, prepare to stop, and check the left lane to see if it is clear so you can turn, in case of a vehicle-pedestrian collision
Exit from intersection/side road	Wait a little longer, even if you have the right of way, if visibility is poor

In defensive driving, it is very important to have a backup plan and to imagine a few possible scenarios. Most drivers assume that everything is going according to the rules, that other road users are following the rules, that no one around them is making a mistake, and that unforeseen situations are rare. The reality of traffic is exactly the opposite. Human error is the primary cause of 95% of traffic accidents.

Mistakes happen all the time, and the difference between a novice driver and an experienced (well-trained) driver lies in how they handle these situations.

A fundamental principle of preventive-defensive driving is to always have a Reserve Plan (Plan B). In this case, it is important not to rely on a single scenario, but to constantly ask ourselves: What might happen in the next second?

Example: when driving behind another vehicle, it is not enough to simply maintain a safe following distance. It is important to consider what you would do if the vehicle in front brakes suddenly. Do you have enough space to stop safely? Is there enough room to swerve to avoid a collision? Is there a clear area (space) to the side (left or right)? Or, when driving in a congested lane, we must ask ourselves if there is a way to avoid a collision in case someone cuts in front of the vehicle we are driving without checking. If we are blocked in a traffic jam with no room to maneuver, have we effectively lost control? The same can happen in an area with pedestrians. We shouldn't just look at the crosswalk; we need to watch the people on the crosswalk, analyze their position on the crosswalk, intuit what the people on the crosswalk intend to do, and observe their body language, because most of the time their reaction comes before the rule.

The principles of preventive-defensive driving require us to constantly run through these scenarios in our minds—not in a panicked or anxious way, but in a conscious and controlled manner. This is an exercise in anticipation that, over time and with the experience gained behind the wheel, automatically becomes routine. Once we already have a plan in mind for possible situations, we no longer react chaotically; we act quickly, clearly, and efficiently because "we've been there before"—we've already experienced this situation mentally.

That is why it is important to constantly ask ourselves: if something happens right now, what is our solution? Perhaps we need to leave more room to maneuver, perhaps we need to adjust our position on the road, or perhaps we need to slow down to give ourselves more time to react.

A defensive driving plan essentially means adopting a preventive driving style. This approach drastically reduces the risk of accidents, minimizes premature wear and tear on

vehicle components (brakes, tires, suspension), and optimizes fuel efficiency.

Here's how this driving style specifically affects your vehicle and your driving experience:

A. Extending the vehicle's lifespan

- **Brake system wear:** Anticipating traffic and maintaining a safe following distance allow for smooth deceleration (engine braking), reducing the need for sudden braking and protecting the brake pads and rotors;
- **Tire and suspension condition:** Avoiding high-speed turns and driving over potholes prevents wheel misalignment, tire deformation, and suspension wear.

B. Fuel efficiency and cost savings

- **Fuel economy:** Gradual acceleration and maintaining a constant speed help the engine operate at optimal parameters, reducing fuel consumption;
- **Insurance costs:** A clean driving record, free of incidents or accidents over the long term, provides access to more favorable rates for auto insurance policies.

C. Active and passive safety

- **Maneuvering space:** Maintaining a proper distance from the vehicle ahead gives us the necessary reaction time to avoid a sudden obstacle;
- **Vehicle stability:** Adjusting speed to road conditions (wet pavement, black ice, reduced visibility) prevents loss of traction and unwanted intervention by electronic stability control (ESC) systems.

D. Reducing stress and fatigue

- By avoiding aggressive driving and unnecessary lane changes, noise levels inside the cabin are reduced, and psychological comfort increases significantly on long drives.

3.3 The correct position of the right foot relative to the vehicle's pedals in defensive driving

The correct positioning of the right foot relative to the pedals is essential for precise vehicle control, safety, and comfort, allowing for quick and accurate switching between the accelerator and brake pedals.

The basic position (pivot):

- A. **Heel on the floor:** Place the heel of your right foot on the floor of the vehicle, positioned directly over the brake pedal or slightly to the right, in the space between the brake and accelerator pedals (Fig 3);



Fig 3: The position of the driver's heel relative to the vehicle's pedals

- B. **Pivoting:** This position allows the foot to pivot (rotate) on the heel to transition from braking to accelerating without having to lift the entire foot off the floor;

- C. **The active part of the foot:** Use the ball of your foot to press down on the pedals, not your toes or the middle of your foot.

Important rules for use

A. Alternation: The right foot controls both pedals (for both manual and automatic transmissions), alternating between them;

B. Safety position: When you are not accelerating, your foot should always be positioned over the brake pedal;

C. Knee angle: Your leg should remain slightly bent even when the pedals are fully depressed;

D. No "heel in the air": Avoid keeping your foot in the air, as it tires more quickly and reduces braking precision.

Differences based on the vehicle's transmission:

- **Manual transmission:** The left foot is used exclusively for the clutch, and the right foot for the brake and accelerator;
- **Automatic or Continuously Variable Transmission (CVT):** The left foot should rest on the dead pedal, with the right foot used exclusively for both pedals.

The most common mistake drivers make in this situation is keeping their right foot on the accelerator pedal instead of the brake pedal. If an imminent danger arises and they need to react, their foot instinctively goes to the accelerator pedal. This is when the situations we see in many accidents occur. Instead of pressing the brake pedal, they press the accelerator pedal, or worse, press both pedals consecutively with their right foot.

The correct position of the right foot on the accelerator pedal (with the heel resting on the floor and the ball of the foot pressing the pedal at an angle of approximately 45 degrees) ensures precise speed control and allows for a quick shift to the brake. This posture prevents muscle fatigue and cramps and shortens reaction time in emergency situations.

To understand exactly how this position affects us, here are the main points to keep in mind:

- **Reaction time:** By keeping the heel on the floor, the foot acts as a lever. We can shift our weight from the accelerator to the brake in a fraction of a second. If we lift the entire foot, the movement becomes more cumbersome and the risk of catching or pressing both pedals simultaneously increases;
- **Force modulation (precision):** When the heel is fixed, we have much greater sensitivity in the sole of the foot, allowing us to press the pedal progressively. This prevents sudden acceleration and braking, contributing to optimal fuel economy;
- **Correct angle:** The seat should be positioned so that, with the foot fully extended on the floor (behind the pedal), the knee remains slightly bent. An incorrect angle (too close or too far) strains the knee and hip joints, causing fatigue and increasing reaction time during emergency braking;
- **Pain prevention:** An incorrect posture locks the joint and overworks the tendons, causing pain in the ankle and calf areas over long distances.

Our recommendation - and that of experts in defensive driving: Is to keep the sole of your right foot over the brake pedal, with your heel resting on the floor. In this position, your foot is already positioned for the most important pedal—the brake. As mentioned, your heel should rest on the floor of the vehicle, not in the air. If we keep our foot

suspended with the heel in the air, it tires quickly and we lose precision. We keep the heel down and pivot at the ankle. When we want to accelerate, we rotate the sole of the foot to the right, where the accelerator pedal is located. When a hazard arises, or we want to brake, we instantly return the sole of the foot to the brake pedal without moving it from its current position. It is a short, natural, and quick movement.

3.4 Proper use of the safety belt and its position relative to the driver's body while driving, and defensive driving

Proper use of the safety belt is one of the simplest and most effective safety measures on the road. This rule is often ignored, especially by passengers in the vehicle. However, traffic laws establish requirements for both the driver and the passengers in the vehicle.

According to traffic laws, every adult is responsible for their own safety on the road. If an adult passenger does not wear a seat belt, they are personally liable, and failure to comply with this requirement while traveling in a vehicle may result in administrative penalties. Additionally, the driver may be penalized if they do not wear a seat belt or if they fail to ensure that minors are transported under appropriate conditions ^[10].

Proper safety belts positioning is essential for preventing serious injuries in the event of a collision. It should always lie flat against the body, be free of twists, and be adjusted to the driver's height.

Here are the essential rules for properly positioning your vehicle's seat belts, ensuring both safety and comfort:

A. Diagonal upper section

- **Clavicle area:** The belt should go over the middle of your shoulder and across your collarbone, not across your neck or the outside of your arm;
- **Height adjustment:** Use the height adjustment mechanism on the seat post to position the belt correctly so that it does not cut into your neck;

B. Lower part (pelvic):

- **Low on the hips:** It should sit over the pelvic bones (hips), as low as possible;
- **Not over the abdomen:** The seat belt should never rest on the belly or stomach, as this can cause serious internal injuries in the event of a collision.

C. The user's body position and safety belt tension:

- **Back drivers attached to the seat:** The driver must sit upright, with their back against the seat back;
- **No space (snug fit):** The safety belt must be tight, with no slack. After fastening, gently pull the diagonal strap upward to eliminate any slack;
- **Distance from the steering wheel:** Maintain a distance of approximately 25–35 cm between your chest and the steering wheel to allow the airbag to deploy properly.

Fig 4 illustrates the correct positioning of a vehicle's safety belts in relation to the driver and passengers position.



Fig 4: The proper use of safety belts in relation to body position in a vehicle

Incorrect use of the safety belt can completely negate its effectiveness, turning it into a major risk factor in the event of an accident. To ensure maximum protection, always check the official vehicle safety guidelines.

The most common and dangerous mistakes made by drivers or passengers when using vehicle safety belts are ^[11]:

- **Wearing the safety belt under the arm or across the back:** Placing the safety belt under the shoulder or across the back (for comfort) allows the body to slide forward uncontrollably, leading to a severe impact of the head against the steering wheel or dashboard and strangulation;
- **Twisted safety belt:** A twisted safety belt distributes the force of the impact incorrectly across the body, potentially causing severe cuts and rib fractures in the event of an accident;
- **Incorrect positioning of the safety belt across the abdomen:** The safety belt must pass over the pelvic bones (under the belly), not across the stomach. Otherwise, in the event of an impact, it can cause fatal internal injuries;
- **Intentionally loosening the tension of the safety belt's retractor:** Some people use "adjustment clips" or leave the belt loose. A gap wider than 2–3 cm allows the body to gain speed before being restrained by the belt, significantly increasing the force of the impact;
- **Incorrect adjustment of the safety belt height:** If the upper anchor point is too low or too high, the safety belt risks passing directly over the neck. This can cause severe cervical injuries in the event of a high-speed impact;
- **Wearing very thick clothing:** Voluminous jackets create a dangerous "gap" between the body and the safety belt. It is recommended that the safety belt be fastened directly over thin clothing, with the jacket worn over the belt;
- **Incorrect use of safety belts by pregnant women:** Safety belts must be worn correctly: the diagonal strap should be positioned between the breasts, and the lower strap as low as possible across the pelvis, below the abdomen, and under no circumstances directly over the fetus (when safety belts are worn by pregnant women). Romanian traffic laws exempt visibly pregnant women from the requirement to wear a safety belt. This provision is mentioned in the Regulation on the Application of the Highway Code (Government Decision No. 1391/2006, Art. 97, paragraph 4) ^[12]. However, doctors and car safety experts strongly recommend the use and correct positioning of the safety belt for the protection of the mother and the fetus;
- **Using the same safety belt for two people:** Sharing a seatbelt (for example, while holding a child in your arms) pushes passengers toward each other in the event of a collision, as the physical forces exceed a person's ability to hold the other person.

Wearing a safety belt correctly is the cornerstone of defensive driving, as it keeps you in the driver's seat in the event of an impact or sudden braking. This allows us to maintain control of the steering, initiate evasive maneuvers, and drastically reduce the risk of bodily injury.

Here's how wearing a safety belt properly ties directly into the principles of defensive driving:

- **The efficiency of active safety systems:** The seatbelt works in tandem with the airbag. Without it, we risk

being thrown into the steering wheel before the airbag deploys, turning a safety feature into a major hazard;

- **Driver reaction time:** Staying in the seat helps prevent us from being thrown from side to side, allowing us to quickly assess the traffic situation and react in time to avoid a collision or an obstacle;
- **Prevention of incapacitating injuries:** By distributing deceleration forces across the strongest parts of the body (pelvis and chest), the seat belt prevents serious injuries that could trap us in the vehicle in situations requiring emergency evacuation (e.g., fire or submersion in water).

3.5 The volume of ambient music in the vehicle cabin and defensive driving

Music is a constant companion in our daily activities, while we exercise, and during our travels. It is worth reflecting on how the volume and type of music we listen to influence our behavior on the road. There are various theories regarding the effect of music on driving style. In this context, a series of studies have been conducted, which also aimed to improve road safety. These studies show that not only the volume but also the type of music influences our behavior behind the wheel.

The volume of ambient music in the passenger compartment has a direct and significant impact on a driver's ability to practice preventive and defensive driving.

Defensive driving involves anticipating hazards, maintaining maximum vigilance, and reacting quickly to traffic stimuli. Music played at high volume (over 85–90 dB) transforms the passenger compartment from a space for concentration into one that distracts attention, increasing the risk of accidents ^[13].

Effective preventive and defensive driving in this context means managing the interior environment of your vehicle by:

- **Moderate volume:** The music should allow you to hear outside noises at all times;
- **Type of music:** Classical or slow/relaxing music played in the background can help maintain the calm needed while driving, reducing stress, unlike upbeat music, which can cause agitation;
- **Fatigue:** On long drives, music can prevent fatigue, but it must be kept at a level that does not cause auditory fatigue.

The impact of high car radio volume on road safety in defensive driving is as follows:

- **Decreased reaction time:** Studies show that loud music can slow a driver's reaction time by up to 20%. A driver listening to music at maximum volume needs more time to process an unexpected situation (a pedestrian crossing the street, sudden braking);
- **Masking essential sounds:** Loud music drowns out critical traffic sounds, such as emergency vehicle sirens, other drivers' horns, or the sound of screeching tires;
- **Cognitive distraction:** Loud music requires mental processing, taking away from the brain resources needed for monitoring the road, checking mirrors, and anticipating hazards;
- **Increased risk of aggressive behavior:** Fast-paced, loud music can increase heart rate and cause drivers to unconsciously accelerate or drive more aggressively.

One of the scientists who has studied this topic is Warren Brodsky, a professor of music psychology and director of

the Music Science Laboratory in the Department of Art at Ben-Gurion University in Israel. In 2015, he published a paper titled "*Driving with Music: Cognitive-Behavioral Implications*" ^[14].

When driving a car, it is important *to maintain an optimal volume that is not irritating* and is appropriate for the situation. It is also best not to force yourself to listen to music genres that do not suit you, even if it is classical music, which, in principle, poses the lowest risk. Noise in the car as a factor that reduces the driver's concentration.

One unwanted phenomena that makes it difficult to listen to music in the car is excessive noise. Automakers are constantly improving soundproofing technologies for vehicle interiors, but there are also ways to improve noise reduction on your own.

Accessories that help improve road safety include:

- Steering wheel-mounted radio controls;
- Control adapters compatible with most car brands;
- Adapters for Bluetooth hands-free kits;
- High-quality, high-selectivity car antennas equipped with an anti-interference filter and an amplifier that improves the received signal, because any noise, static, or radio station interruptions can be frustrating for drivers.
- Car audio system quality: our senses become more acute when the sounds and tones reaching us are clear. No one likes a faulty sound or having to strain their ears to try to guess the song. On the other hand, even your favorite music played in a way that's too "shrill and harsh" introduces an element of irritation and nervousness. This makes us tire quickly, and the trip becomes so unpleasant that we'd rather drive without music. Therefore, a key issue is the sound quality of the car audio system. The better the equipment, the greater the listening satisfaction. Without a doubt, it's worth investing in a good player and carefully selecting car audio cables and speakers.

Recommendations from the authors

A. The "hear the ambulance" rule (golden rule): Adjust your car radio volume so that you can hear a siren from a reasonable distance. The volume should be at a level that allows you to carry on a normal conversation with passengers or hear the sound of the wind against the window;

B. Turn down the volume in critical areas: Lower the volume or turn off the music completely at busy intersections, in low-visibility conditions (fog, heavy rain), or when parking or backing up;

C. Pay attention to your playlist: Avoid very upbeat music (over 120 BPM) if you tend to get agitated while driving. For long drives, choose balanced music that keeps you alert without causing agitation or deep drowsiness.

3.6 The correct use of vehicle headlights at night and defensive driving

The correct use of lights at night and adopting a preventive and defensive driving style are essential, as reduced visibility increases the risk of accidents. In EU countries, as well as in Romania, traffic regulations impose strict rules to ensure your own visibility and to avoid blinding other road users.

The basic (regulatory) rules for the proper use of vehicle headlights at night are as follows:

A. Low beam (headlights on motor vehicles):

- **Obligatory:** In unlit areas, outside built-up areas, and in any conditions of reduced visibility (fog, heavy rain);
- **Adjustment:** Make sure your headlights are properly adjusted so as not to blind oncoming drivers or those ahead (check via the rearview mirrors). Headlights must illuminate the road for a minimum distance of 30 meters.

B. High beam (headlights on motor vehicles):

- **Usage:** Use exclusively on unlit roads outside built-up areas when there are no other vehicles ahead;
- **Switching (golden rule):** Switch to low beams at least 200 meters before encountering an oncoming vehicle, or when you are less than 100 meters from a vehicle traveling in front of you;
- **Winding roads/curves:** Switch to low beams before ascending a hill or before entering a curve so as not to blind oncoming drivers.

C. The vehicle's parking lights:

- They are used exclusively to signal the dimensions and presence of a vehicle parked on the side of the road at night or in conditions of reduced visibility.

D. The vehicle's front fog lights (headlights) and rear red fog light:

- They should be used exclusively in conditions of dense fog, heavy rain, or heavy snowfall, in conjunction with the low beam. Do not use the high beam in foggy conditions, as the light reflects and further reduces visibility.

Fig 5 illustrates the effect of blinding drivers of oncoming vehicles with the high beams of a vehicle's headlights.



Fig 5: The effect of blinding drivers of oncoming vehicles with the high beam headlights of a vehicle

Blinding by long-range headlights impairs defensive driving by compromising reaction time and the ability to anticipate hazards. To prevent accidents caused by temporary loss of visibility, drivers should reduce speed, avoid direct eye contact with the light, and use landmarks on the right side of the road to maintain direction. Defensive driving involves anticipating hazards and driving prudently.

Temporary blindness caused by another road user alters this dynamic in the following ways:

- **Loss of spatial orientation:** When temporarily blinded, the brain can no longer accurately estimate distances, speeds, or the positions of vehicles on the road, which exponentially increases the risk of a collision;
- **Reduced field of vision:** The time it takes for the eyes to adjust to darkness after sudden exposure to bright light can create a “moment of blindness” during which the car may travel dozens of meters without the driver seeing anything;
- **The “backlighting” effect:** Light reflected in the rearview or side mirrors can cause the same visibility issues, requiring the mirrors to be switched to the “night” (antiblinding) position.

Recommendations from the authors for defensive driving at night

Defensive driving means being alert, anticipating hazards, and reacting in time to avoid dangerous situations by:

- **Adjust your speed to road, weather, and traffic conditions:** Drive at a speed that allows you to stop safely within the distance illuminated by your headlights;
- **Increase your following distance:** At night, the distance between you and the vehicle ahead should be greater than during the day, to give you time to react in case of sudden braking;
- **Combat fatigue:** Do not drive if you are tired. Fatigue drastically reduces your alertness. Take regular breaks, do some physical exercises to refresh yourself, and wash your eyes and face with cold water;
- **Avoiding glare:** If an oncoming driver does not switch from high beams to low beams, look toward the right edge of the road (the center line), not directly into their headlights;
- **Checking visibility:** Keep the windshield, windows, and mirrors clean, both inside and out. A dirty windshield scatters light and reduces visibility;
- **Reduce dashboard light intensity:** Excessive dashboard brightness can cause glare on the windshield and strain your eyes;
- **Watch out for pedestrians and cyclists:** They are much harder to spot. Slow down when approaching pedestrian zones or in built-up areas.

3.7 Interior ambient lighting in vehicles and defensive driving

Ambient cabin lighting and defensive driving are two concepts that, although they seem distinct—one relating to comfort and aesthetics, the other to safety—interact significantly when driving at night or in conditions of reduced visibility.

Although interior ambient lighting in vehicles is often viewed as a luxury feature designed for aesthetics or comfort, it can significantly influence road safety and the driver's ability to apply the principles of defensive driving.

The relationship between ambient lighting in the cabin and defensive driving is a balance between the driver's psychological comfort and maintaining their ability to react. Although they may seem like merely a design element, they directly influence *vigilance* and *visibility*.

Here's how these two concepts are interconnected:

A. Effects on the driver's alertness and mental state

Defensive driving depends heavily on the driver's state of mind and level of attention. The main preventive measures are:

- **Reducing fatigue:** Discreet ambient lighting (usually in shades of blue or warm white) can reduce feelings of isolation and fatigue at night, helping the driver stay more alert;
- **Reducing visual stress:** Lights that are too intense or colors that are too bright (bright red, purple) can strain the eyes, affecting the ability to quickly spot hazards on the road. In this regard, it is recommended to eliminate these colors or reduce them as much as possible so that they do not impair visual acuity.

B. Impact on external visibility (critical factor)

A fundamental principle of preventive-defensive driving is being aware of your *observation surrounding environment*.

In this context, the following appears:

- **Reflection effect:** If the interior lights are too bright, they can reflect off the windshield or side windows, obscuring external obstacles (pedestrians, vehicles without lights);
- **Visual adaptation:** The human eye needs time to adjust from the darkness outside to the light inside. In defensive driving, it is recommended that ambient light intensity be set to a minimum so as not to compromise the driver's "night vision."

C. Technology and active safety

Modern vehicles integrate ambient lighting into their safety systems by including:

- **Visual warnings:** Some vehicles use ambient LED strips to provide the driver with preventive warnings (for example, they flash red if another vehicle is in the blind spot or if the distance to the car ahead suddenly decreases);
- **Human-machine interface:** Ambient lighting can intuitively confirm the activation of certain assistance systems, allowing the driver to keep their eyes on the road without having to look for confirmation on the dashboard.

In the following, we will scientifically explain what happens at night to the eyes of road vehicle users. Human eyes have two modes of vision: daytime and nighttime.

When there is abundant light, the human eye relies primarily on the *cones*. Cones are a type of *photoreceptor cell* located in the retina of the human eye; they are essential for color vision and visual acuity in well-lit conditions (photopic vision). The main problem with these cones is that they require a great deal of light to function properly.

When it gets dark, the *rods* take over. Rods (rod cells) are photoreceptors in the human retina that are specialized for night vision, peripheral vision, and low-light conditions. Unlike cones, they perceive black-and-white images, are extremely sensitive to light (not to colors), and are concentrated mainly at the periphery of the retina. They provide scotopic (night) vision and the detection of movement in the dark. There are approximately 92–125 million rods in the retina. The rods in the human eye contain *rhodopsin*, a light-sensitive protein that allows them to function in dim environments. They are much more sensitive to light than the cones (which function during the day). Rods are 100 times more sensitive to light than cones. The problem with the rods in the human eye is that they need 20–30 minutes to fully adapt to the dark. This adaptation depends directly on rhodopsin, which is essentially the "fuel" for night vision. Rhodopsin regenerates in the dark but is quickly destroyed by light—which is exactly what happens when we're exposed to bright, vivid ambient light.

If a driver is exposed to bright ambient light like in Fig 6—even relatively dim light—the human eye never fully enters night vision mode, because the retina cannot fully recover, and the rods do not reach their maximum sensitivity. Furthermore, the pupil of the eye—the opening through which light enters—no longer dilates fully in the presence of light, regardless of how bright or dim it may be. This means that less light from outside enters the eye. The result: we see less clearly in the distance; we have a harder time perceiving contrast, especially in low-light conditions (pedestrians, cyclists), and we react more slowly.



Fig 6: Aspects of ambient lighting in vehicle interiors that affect defensive driving

It is important to note that the cones in the human eye are concentrated in the center of the retina, while the rods are concentrated at its periphery. This is why we see traffic objects better at night if we don't stare directly at them, but look slightly to the side. If there is light indoors, we lose this advantage as well.

Blue light, which is most commonly found in modern ambient lighting and displays, is even more damaging to the retina and tires our eyes much more quickly.

The ambient lighting in the vehicle's interior should support defensive driving by reducing eye strain, improving spatial awareness, and helping the driver stay alert at night. Proper lighting helps you anticipate and react quickly in traffic.

A defensive driving is optimized by using these lights as follows:

- **Reduced reflection and contrast:** A cabin completely plunged into darkness, combined with the intense brightness of the dashboard screens, can create a contrast that strains the eyes. Soft, warm ambient lighting softens this contrast, protecting your eyesight and helping you stay focused on the road;
- **Anticipation and control ergonomics:** Instead of fumbling for controls (climate control, driving modes), subtle ambient lighting highlights the contours and buttons, allowing you to operate them intuitively without taking your eyes off the road;
- **Preventing fatigue and sleeplessness:** Cool tones (such as blue or cool white) can enhance alertness at night. On the other hand, warm colors (such as orange or subtle red) help promote mental relaxation and prevent irritability in heavy traffic;
- **Passenger safety:** Subtle lighting at floor or door level helps you quickly check the condition of the cabin and passengers at a glance, without having to turn on the central overhead light (which would drastically reduce your visibility through the windshield).

Recommendations from the authors

- **Low intensity for dashboard and ambient lights:** Adjust the cabin brightness so that it doesn't cause glare on the windows, or turn them off entirely if possible;
- **Neutral colors:** Use shades of blue or white for ambient lighting to minimize eye strain;
- **No distractions:** Avoid ambient lighting kits that "dance" to music or change colors rapidly, as these distract from monitoring traffic.

3.8 Using winter tires in the summer and defensive driving

A modern tire is a complex structure made up of over 200 different materials (natural and synthetic rubber, steel,

nylon, and polyester) grouped into interdependent components, specifically designed to remain flexible at temperatures below 7°C and provide traction on snow. The basic composition of a winter tire includes the following categories of materials:

A. Elastomers (rubber compound)

- **Natural rubber:** Extracted from rubber trees (Hevea), it provides elasticity and flexibility at very low temperatures. Winter tires use a higher proportion of natural rubber than summer tires to prevent stiffening in cold weather;
- **Synthetic rubber:** Polymers derived from petrochemicals (such as styrene-butadiene), added to optimize wear resistance and provide long-term durability.

B. Reinforcing and filler agents

- **Silicon dioxide (silica):** A vital ingredient in winter tread compound. It significantly improves traction on wet or icy roads and reduces rolling resistance;
- **Carbon black (soot):** Used alongside silica to stiffen the rubber compound and increase its resistance to wear and tear.

C. Chemicals and additives

- **Sulfur:** The ingredient used in the vulcanization process; it forms bonds between rubber molecules and provides the characteristic elasticity;
- **Oils and plasticizers:** Special oils of plant origin or petroleum derivatives, used to adjust and maintain the hardness and flexibility of the compound at sub-zero temperatures;
- **Anti-degradants and antioxidants:** Chemicals that protect the tire against cracks caused by the action of oxygen, ozone, and ultraviolet rays.

D. Reinforcing materials (internal structure)

- **Textile and nylon cords:** Fibers arranged in layers to maintain the tire's shape and provide shock and pressure resistance (for bias-ply tires). They are also known as bias tires. Textile cords, which are the inner layers of fiber reinforcement (polyester, nylon, or rayon). Almost all modern tires for passenger cars, SUVs, and light trucks use textile cords in the carcass construction to provide flexibility and shock absorption [15];
- **Steel cord (bead wires):** Rigid rings made of rubber-coated steel wire; they ensure the tire is sealed and held securely on the rim;
- **Metal cables (belts):** High-strength steel used inside the tire to stabilize the tread and prevent punctures (in radial tires).

The structural components of a tire are:

- **Tread:** The outer part that comes into direct contact with the road surface. Its role is to provide grip, traction, and water drainage, and it is designed with a specific tread pattern;
- **Innerliner:** A thin layer of synthetic rubber located on the inside. It replaces the traditional inner tube and ensures airtightness, maintaining pressure;
- **Sidewall:** The area between the tread and the bead. It protects the tire from curb impacts and contains all important markings and labels (dimensions, load/speed indices);
- **Beads:** Rigid rings made of braided steel wires and covered with rubber. They ensure a tight and perfectly secure fit of the tire on the rim;

- **Casing:** The tire's skeleton, consisting of thin layers of cord (textile fibers or polyester) embedded in rubber. It supports the vehicle's weight and transmits braking and acceleration forces;
- **Steel belts:** Layers made of thin steel cord, positioned beneath the tread. They provide rigidity and stability at high speeds, protecting the carcass against punctures;
- **The shoulder:** The transition zone between the tread and the sidewall, essential for maintaining stability when cornering;
- **Reinforcement plies:** Additional layers that provide mechanical strength and protect areas subject to wear and mechanical stress. Reinforcement plies are additional layers of material (nylon, polyester, rayon, or steel fabrics) integrated into the tire's internal structure. Their role is to reinforce vulnerable areas—such as the sidewalls or the tread—to increase the tire's strength, durability, and load-carrying capacity (e.g., XL [Extra Load] or reinforced tires; Run-Flat [RFT] tires; or off-road tires).

Using winter tires in the summer is dangerous and ineffective. Their compound (rich in silica) softens excessively at temperatures above 7°C, leading to poor traction, significantly longer braking distances, and accelerated wear.

To understand exactly how vehicle performance is affected, here are the main reasons why appropriate measures need to be taken:

- **Increases braking distance:** On dry roads and in high temperatures, a car equipped with winter tires requires a stopping distance up to 20% longer than one equipped with summer tires;
- **Reduces tire grip on the road surface and increases the risk of hydroplaning:** The tread pattern and grooves of winter tires are designed for snow and mud. On hot asphalt, they become unstable in turns, and in the rain, the risk of hydroplaning increases significantly due to the inability to effectively disperse water;
- **Accelerated wear:** Soft winter rubber degrades rapidly in heat. The tread can deform, leading to permanent damage to the tire in a single season;
- **Increased fuel consumption:** Tire deformation and inadequate traction generate higher rolling resistance, which will increase the vehicle's fuel consumption;
- **Legal issues and fines:** In many European countries, using tires that are not season-appropriate can result in substantial fines during a traffic stop or if you are involved in an accident.

The following are additional risks to vehicle safety [15]:

- **Low performance in the rain:** The risk of hydroplaning increases because the tread pattern of winter tires can no longer effectively disperse large amounts of water from the road during the warm season;
- **Accelerated wear:** The soft compound wears out much faster on dry, hot asphalt. A winter tire used for an entire summer loses a significant amount of its effectiveness for the following cold season;
- **Instability in curves:** The car's handling becomes imprecise, with the vehicle feeling "sticky" and difficult to control during sudden evasive maneuvers (the moose test).

To demonstrate the effectiveness of winter tires in summer, researchers [16], tested two sets of premium summer versus

winter tires during the summer, from one of the leading tire manufacturers, Michelin (Fig 7). The tests focused on “emergency braking” on dry asphalt.

The research was carried out at speeds of 50 km/h, 100 km/h, and 130 km/h using a high-performance Mazda CX-5 equipped with an efficient Skyactiv braking system on a test track with a high-friction surface (asphalt), under high ambient temperature conditions (approx. 30–32°C).

The Mazda CX-5 Skyactiv is equipped with a hydraulic braking system featuring ventilated discs on the front axle and solid discs on the rear axle. It includes advanced electronic braking assistance for optimal stopping power, i-Activsense technologies, and an electronic parking brake. The results we are presented in Table 2.

Table 2: Results obtained from research conducted on winter tires used in summer ^[16]

Summer tires		Winter tires	
Speed (Km/h)	Braking distance (space) achieved (m)	Speed (Km/h)	Braking distance (space) achieved (m)
50	8	50	10
100	32	100	45
130	56	130	75

The essential technical details of the braking system of the MAZDA CX-5 used during the research are as follows ^[17]:

- **Electronic braking systems:** Includes anti-lock braking system (ABS), electronic brakeforce distribution (EBD), and emergency brake assist (EBA);
- **Stability control:** Models feature dynamic stability control (DSC) and traction control (TCS);
- **Parking brake:** Depending on the trim level and model year (particularly facelift models), this can be operated manually (mechanically, via a lever) or electrically (EPB), integrated with a redesigned center console;
- **i-ACTIVSENSE driver assistance technologies:** Includes Smart City Brake Support (SCBS), which monitors traffic ahead and can automatically apply the brakes to avoid or mitigate the severity of a collision at low speeds.

At the same time, the Skyactiv system on the Mazda CX-5 is a comprehensive suite of technologies designed to reduce fuel consumption and emissions without compromising driving pleasure. This technology incorporates major innovations in the engine, transmission, chassis, and body.

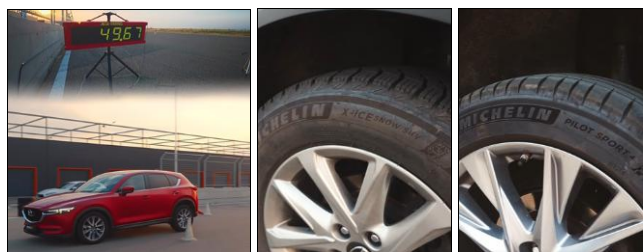


Fig 7: The Mazda CX 5 car and the tires used in the experimental research ^[16]

The technology is divided into several main components ^[17]:

A. Revolutionary Engines

- **Gasoline (Skyactiv-G and e-Skyactiv G/X):** These engines boast the world’s highest compression ratio for a production gasoline engine (13:1) or even (14:1). This ensures much more efficient combustion, delivering more torque at low RPMs and improved fuel economy;

- **Diesel (Skyactiv-D):** Unlike other diesel engines, these have an unusually low compression ratio (14:1). This allows for cleaner and more complete combustion, resulting in low emissions and extremely quiet operation.

B. Advanced transmissions

- **Skyactiv-Drive:** A 6-speed automatic transmission that combines the advantages of a classic automatic transmission (with torque converter) with those of a dual-clutch transmission, offering quick gear changes and low fuel consumption;
- **Skyactiv-MT:** A 6-speed manual transmission that is extremely precise and light, inspired by the legendary Mazda MX-5 sports car;

C. Body and chassis (Skyactiv-Body and Skyactiv-Chassis)

- **Safety and weight:** The body utilizes ultra-high-strength steel, making it lighter than previous models while also being significantly stiffer, which improves safety in the event of a collision;
- **Driving dynamics:** The suspension is designed to provide long-distance comfort and excellent stability in corners. The system is complemented by G-Vectoring Control technology, which adjusts engine torque based on steering wheel movements to optimize grip and reduce body roll.

We present aspects of the experimental research in Fig 8.

Based on an analysis of the data obtained from experimental research, we consider that the factors influencing braking distance when using winter tires in the summer are as follows:

- **Compounds in winter tire construction:** Winter rubber is designed to remain flexible at temperatures below 7°C. In summer, when the pavement frequently exceeds 15°C—and on scorching summer days when the air temperature exceeds 30°C and the ground temperature reaches 50–60°C—this material becomes excessively soft. Due to the partial “melting” of the tread at the microscopic level, traction **decreases** dramatically;
- **Deformation of winter tire tread blocks:** Due to their structure and the large number of sipes (fine grooves), the rubber blocks flex and deform significantly when braking on dry asphalt, increasing the stopping distance;
- **Specific differences in braking distance with winter tires obtained (in meters):** Tests conducted by automotive researchers have shown that, at temperatures above 15–16°C (in our case, over 30°C), vehicles equipped with winter tires in the summer may have a braking distance that is:

- 2 m higher during emergency braking from 50 km/h;
- 13 m higher during emergency braking from 100 km/h;
- 19 m higher emergency braking from 130 km/h.



Fig 8: Aspects during experimental research ^[17]

We observe that braking distance increases proportionally with speed. Using winter tires in the summer seriously “undermines” defensive driving, as their soft compound

overheats. This leads to poor traction, braking distances that are between 20–25% higher, an increased risk of aquaplaning on wet roads, and imprecise steering and braking response during emergency maneuvers.

4. Conclusions

An alert and well-prepared driver does not drive for ideal conditions, but rather for scenarios where something goes wrong or deviates from the norm. For this reason, it is important that, under such conditions, we adjust the speed of the vehicle we are driving, remaining prepared at all times to prevent or avoid an imminent danger. We cannot rely on the fact that nothing can happen to us.

Defensive driving does not mean driving on the highway at the speed limit or exceeding it; it means driving at a speed adapted to the traffic situation and as fast as we, as drivers, can safely manage. The real limit is not the one on the speed limit sign. It is our own limit of control.

Defensive driving does not mean hoping that nothing will happen. It means being prepared at all times, including when something does happen, and when we have options, we have complete control over any situations that may arise.

If we lift our entire foot to switch from one pedal to another, we lose precious fractions of a second and risk “snagging” the pedal or missing it entirely, especially when panicking or under stress. In an emergency, we don’t have the time to analyze the vehicle’s pedals. The human body reacts reflexively.

Wearing your safety belt correctly is essential not only to avoid fines, but also to ensure that the vehicle’s safety systems (such as airbags) function effectively in the event of a collision. Adjust the height of the anchor point on the vehicle pillar (if the model allows) so that the diagonal strap rests naturally on the center of your shoulder.

Driving at night isn’t just about how well we can see, but also about how much time we give other road users to react around us. By following these rules, you will significantly increase your own safety and that of other road users.

On the basis of the data provided by Professor Warren Brodsky in his paper, we were to draw the following conclusions:

- Music influences driving style, traffic violations, errors, and behavior on the road;
- There is irrefutable evidence that one of the main causes of accidents is driver distraction;
- Driver distraction can be caused by fatigue, talking on the phone, texting, or a lack of concentration due to the music in the car;
- The car is the only place where listening to inappropriate music can be fatal;
- Both novice and experienced drivers need to be more aware that music influences their behavior behind the wheel.

Of course, there are times when we’re driving and aren’t paying attention to the music playing in the background. The human brain is able to tune out unnecessary stimuli and focus on what’s important. On the other hand, however, the quality of the sound, its volume, and the type of music being played all influence driving style—and, consequently, the safety of the vehicle’s passengers.

Defensive driving in this situation requires auditory vigilance. Ambient music is beneficial only if played at a volume that allows for continuous monitoring of the surrounding environment.

Ambient lighting can support defensive driving if set correctly (low intensity, warm colors), helping to maintain a calm environment and reduce eye strain. If they are too bright, they become a distraction and a safety hazard. Automakers do not install ambient lighting to help us drive better. They install these lights in the vehicle cabin for commercial and marketing purposes. They look good in the showroom and in advertisements; they give you a sense of luxury and comfort. However, from the perspective of defensive driving at night, these lights are completely useless and actually get in the way. It doesn’t have to be pretty; we need to see clearly, because in the end, it doesn’t matter how good the car’s interior looks—what matters is how quickly we spot the danger ahead.

From a legal standpoint, Romanian law does not explicitly prohibit the use of winter tires during the summer. However, due to rapid wear, the increased risk of accidents caused by altered stopping distances, and potential issues with insurance companies in the event of a traffic accident, the Romanian Vehicle Registry.

In nordic countries, to cope with thick layers of ice, metal studs are added to the composition of some winter tires.

A vehicle’s only point of contact with the road is through its tires, and for complete safety, it must be equipped with tires appropriate for the season. Using winter tires in the summer significantly increases braking distance and reduces handling. This happens because the soft rubber and specific tread patterns become unstable on hot asphalt. For this reason, both industry experts and the Romanian Vehicle Registry recommend using tires designed for each season.

Using winter tires during the warm season compromises active safety due to the following specific hazards:

- Dangerous braking distances: At temperatures above 7°C, winter tires become too soft. In the event of sudden braking, the car will stop significantly more slowly, negating our ability to anticipate and avoid an imminent collision;
- Instability in curves: When maneuvering to avoid an obstacle, winter tires deform excessively, causing a “wobbling” sensation and loss of lateral grip. This causes the vehicle to understeer or oversteer uncontrollably;
- High risk of aquaplaning: The tread pattern and grooves of winter tires are designed to disperse snow and mud, not large amounts of water. On wet pavement, loss of traction occurs much more easily;
- Accelerated wear and risk of winter tire explosion: Hot pavement damages the tire’s internal structure. The tread partially melts, degrading the car’s handling from month to month.

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