

Analysis of Safety Driving Factors for Tracked Vehicles

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Abstract: With the development of society and advances in technology, various tracked engineering vehicles have continuously emerged to adapt to various complex terrains. While improving efficiency, the safety of driving tracked vehicles has become a focus of attention for various units. Unlike small local vehicles, tracked vehicles mainly differ in their longer and wider bodies, complex steering, and limited visibility, which is unfavorable for observation. Therefore, driving tracked vehicles is more difficult than ordinary wheeled vehicles, and it requires higher skills for tracked vehicle drivers. Currently, most drivers who obtain special driver qualifications are still limited to one type of vehicle, and they have not received targeted safety driving training in the early stages of driving. Therefore, there are many safety hazards for driving tracked vehicles. In response to the rapid development of special vehicles in recent years and the increasing number of tracked vehicles, efforts have been made to improve the ability of safe driving of tracked vehicles.

Keywords: Tracked; Vehicle; Driver; Safety; Prevention; Measures

1. Introduction

In recent years, with the rapid development of specialized vehicles in our country, the number of tracked vehicles performing various tasks has been increasing. While efficiency is enhanced, higher safety demands are placed on tracked vehicle drivers. Unsafe driving during task execution can easily lead to tragic accidents. The main factors affecting vehicle safety include vehicle quality, driver condition, driving environment, and driving habits [1]. Studies have shown that humans, vehicles, the environment, and traffic are the four major factors in traffic accidents, with 80% to 90%

of traffic accidents caused by human factors [2]. In tracked vehicle driving, drivers are also one of the crucial factors. Given the uniqueness of tracked vehicles and their frequent maneuvers on complex roads, the integration of driver and vehicle is particularly important. To date, there has been substantial research on safe driving for cars, but less so for tracked vehicles. To effectively mitigate risks, this paper builds on the foundation of automotive safe driving to discuss the factors influencing drivers and the state of tracked vehicles themselves during tracked vehicle operation. It also organizes preventive measures for internal and external factors concerning tracked vehicle drivers, providing a reference for professionals engaged in related occupations.

2. Factors Inherent to Tracked Vehicle Drivers

2.1 Safety Awareness

Safety awareness is a crucial quality for ensuring driving safety. The driving process is governed by awareness, and safety consciousness significantly affects the driver's operation. Despite vigorous safety measures taken by organizations over the years, accidents that result in fatalities still occur due to some drivers' carelessness, fundamentally stemming from a lack of safety awareness. For instance, when driving on regular roads, tracked vehicles often turn too quickly on wide roads, thereby overlooking the vehicle's turning characteristics and the unpredictable factors of pedestrians, posing a significant threat to traffic safety. Similarly, when a driver is in poor mental condition, it can lead to diminished concentration, thereby increasing the risk of unsafe driving. On special roads, due to drivers' lack of judgment regarding road conditions, incidents like rollovers and scraping against culverts occur. It is evident

that most accidents in tracked vehicle driving could potentially be prevented and are often due to inadequate safety awareness by the driver.

2.2 Operating Skills

Operating skills for tracked vehicle drivers specifically refer to the flexible application of driving theoretical knowledge and practical skills. Due to operational needs, tracked vehicles frequently maneuver on complex roads, which requires drivers to master sophisticated driving skills and the ability to troubleshoot common problems. This ensures that drivers can make more accurate judgments about the vehicle's condition while in motion, thereby reducing the risk of accidents [3]. Currently, the training for drivers in units equipped with tracked vehicles is relatively weak, primarily relying on training from other units. Afterwards, most units adopt a "mentor-apprentice" training method for self-training, so the driving skills for tracked vehicles do not receive systematic training, especially in troubleshooting. In most cases, maintenance departments are relied upon for support. Whether a driver can make accurate decisions and skillfully mitigate specific risks often depends on their driving skills and troubleshooting abilities.

2.3 Driving Habits

Driving tracked vehicles differs from operating smaller local vehicles due to the unique structure of these vehicles, which influences driving habits. Good driving habits are essential for safe driving, whereas poor habits can introduce numerous safety risks [4]. For example, when stopping, some drivers of heavy tracked vehicles fail to automatically place their hands on the brake after releasing the brake pedal, leading to incidents caused by the vehicle rolling back. Additionally, adjusting the driver's seat before starting is often overlooked by many drivers, resulting in an inability to fully apply the brakes in emergencies, thus causing accidents.

2.4 Psychological Quality

During the operation of tracked vehicles, drivers may experience tension due to terrain, obstacles, environmental factors, limited visibility, and other vehicles, especially during unexpected events. For instance, if an accident

occurs while the vehicle is in motion, a driver's nervousness may prevent them from assessing the situation accurately, hindering their ability to quickly identify a solution that suits their vehicle's characteristics to minimize the impact of the accident. Moreover, some drivers exhibit behaviors such as speeding, becoming distracted, or even violating driving regulations when driving alone, which can fail to anticipate upcoming issues, all contributing to increased road safety risks.

3. Factors Inherent to Tracked Vehicles

3.1 Maintenance Level of Tracked Vehicles

The maintenance condition of tracked vehicles is a crucial factor affecting safe driving [5]. Implementing a maintenance regimen is particularly important. Surveys have shown that many drivers neglect to check the braking systems and other mechanisms during pre-departure inspections, focusing only on checking the oil, water, electricity, and fluid levels. In one unit's experience, failing to inspect the track plates resulted in a track plate breaking on a hard, flat road. Due to inertia, parts of the track flew towards pedestrians on the roadside, causing injuries. Therefore, comprehensive inspection and maintenance of tracked vehicles before driving are effective measures to ensure safe operation.

3.2 Performance of Tracked Vehicles

In tracked vehicles, as the need for chassis performance evolves towards more automation and user-friendliness, the incomplete mastery of vehicle capabilities by drivers can prevent the vehicle from performing as designed during operations, sometimes even leading to accidents. For example, in certain tracked vehicle models, steering is controlled by the amount of oil directed by the steering brake valve, which determines the operational state of the braking clutch to facilitate turning. This mechanism places higher demands on the stability of the driver's operations. If a tracked vehicle driver is not fully familiar with the vehicle's capabilities, they cannot master the driving technique, thereby compromising safe driving.

3.3 Specific Characteristics of Tracked Vehicles

Due to their large size and limited visibility,

many tracked vehicle models lack rear-view mirrors, making it difficult for drivers to observe their surroundings. When turning, the rear side of a tracked vehicle moves outward in a sliding motion. The general public often lacks understanding of tracked vehicles and does not actively avoid them, which can easily lead to safety incidents during turning maneuvers. Moreover, turning in a tracked vehicle involves accelerating, placing stricter and more precise demands on the driver's gear-shifting speed, timing, and operational accuracy. Effective use of the throttle pedal and control levers in a coordinated "reduce, pull, add" motion is critical. The driving of tracked vehicles has been aptly summarized by predecessors as: heavy foot, firm hand, full throttle. Additionally, reversing a tracked vehicle requires coordination with personnel. In practice, accidents are common when drivers commence maneuvers without sufficient communication with the commanding officers, with any miscommunication potentially leading to incidents.

4. Preventive Measures for Tracked Vehicle Driving

4.1 Preventive Measures for Tracked Vehicle Drivers Themselves

4.1.1 Establish a safe driving awareness

Safe driving awareness specifically refers to enhancing one's own perception of danger or impending danger, the ability to flexibly use multiple senses to assess the surroundings, and the capability to predict safety in advance [6]. For drivers, this means using their ears to listen for road condition signals from vehicles other than the engine sound, and their eyes to gauge the general direction of nearby vehicles. In terms of roads, it involves observing in advance whether roads, bridges, culverts, and other special sections meet the standards for tracked vehicle passage. When passing through swamps, mud, or grassy areas, plan the driving route in advance; if necessary, get out of the vehicle to inspect the road conditions to avoid blind passage and prevent safety accidents.

4.1.2 Develop expert driving skills

Currently, the training of tracked vehicle drivers faces real challenges such as the scarcity of specialized training organizations,

high safety risks, and difficulties in training for driving on special roads [7]. As tracked vehicle drivers, it is essential to train routinely and under self-imposed pressure. For example, when practicing with the vehicle on allowed roads, drivers should use the terrain to simulate and execute precise routes. After passing, they can check the tire tracks to compare and assess accuracy, then reflect on the reasons and ensure no similar issues occur next time. Secondly, they should fully integrate theoretical knowledge with practical driving, like remembering the vehicle's turning radius and braking distance during steering and braking. It is useful to measure the vehicle's turning radius in different gears and understand the impact of rotational speed on the turning radius at an appropriate site, enabling calm and safe risk avoidance in emergencies. Lastly, mastering basic maintenance skills is vital for enhancing driving safety, providing better judgment of the vehicle's operating condition, and thus reducing the risk of accidents.

4.1.3 Cultivating standard driving habits

Driving habits play a crucial role in the operation of tracked vehicles [8], affecting not only the safety of the driver but also that of other pedestrians on the road. Many drivers have historically not developed good driving habits, leading to increased safety risks. Developing good driving habits involves consistent practice in every operation, such as diligently following the preparatory steps before starting, which include external vehicle checks, seat adjustments, gear checks, and checking the throttle pedal. These tasks may seem simple, but many drivers struggle to maintain them long enough to form a habit. After parking, it is important to remind oneself to secure the brake and use a reference point to ensure it is safe before leaving the cabin.

4.1.4 Developing strong psychological qualities

Psychological quality often plays a decisive role during emergency maneuvers. Possessing the psychological strength to remain calm in danger is a fundamental quality for tracked vehicle drivers. Due to the unique nature of their job, tracked vehicle drivers often operate in harsh environments where they must be prepared to drive under any circumstances, illustrating how maintaining strong psychological qualities significantly influences

driving skills. Therefore, it is crucial to cultivate such qualities through regular training [9]. For example, increasing the complexity of road training for tracked vehicles under safe conditions can help train drivers' abilities to manage encounters and improve their psychological resilience. Training can also involve competitive exercises, imposing limits on time and speed to create a tense atmosphere, and setting up hazardous scenarios, such as simulating unexpected pedestrian and vehicle interactions without the driver's knowledge, to train them to handle emergencies without panic.

4.2 Preventive Measures for Tracked Vehicles Themselves

4.2.1 Maintenance

The stability of tracked vehicles is a basic guarantee for safe driving. Routine maintenance and pre-departure checks should be thorough and not limited to just basic inspections of oil, water, electrical, and fluid systems. It is equally important to inspect the moving and transmission parts. Due to the heavy nature of tracked vehicles, connections can easily become loose. Inspections can be conducted using visual checks, tapping, listening, and touching to ensure that no faulty vehicles are used for tasks. When implementing a maintenance regime, strict inspection standards should be adhered to, with specific people, vehicles, and standards designated to ensure maintenance quality, thereby enhancing the vehicle's emergency avoidance capabilities when unexpected situations arise.

4.2.2 Theory guiding practice

Theory and practice are the foundations of skill development; without theoretical support, practical application is not feasible. In terms of safe driving of tracked vehicles, understanding the function and structure of each component is essential to maintain safety when the vehicle malfunctions. Additionally, theoretical knowledge informs whether a tracked vehicle can safely traverse special road sections and the consequences of forcing a passage. Lastly, during emergency maneuvers, vehicle performance must meet the driver's expectations, such as mastering the braking distance in different gears, turning radius, and rotational speed during operation, all underpinned by theoretical knowledge to

achieve a seamless integration of driver and vehicle.

4.2.3 Mastering Vehicle Specificity

Tracked vehicle drivers are also known as special vehicle drivers fundamentally due to the vehicle's unique characteristics [10]. As a tracked vehicle driver, it is essential to be clear about the vehicle's specific features and fully understand various operational procedures and regulations. For instance, when turning, a tracked vehicle must have enough space to ensure safety in emergencies. Speed and engine rpm must be controlled during turns to prevent accidents due to the need to accelerate while turning, thus overlooking other road hazards. Additionally, reversing a tracked vehicle must always be directed by another person as required by regulations; drivers should never rely on luck or reverse the vehicle privately.

5. Conclusion

In summary, this paper aims to effectively prevent safety issues in driving tracked vehicles by identifying factors related to the drivers themselves and factors external to the drivers, proposing preventive measures based on both. Based on the characteristics of tracked vehicle drivers, the paper discusses potential issues and practical training methods concerning drivers' safety awareness, operating skills, driving habits, and psychological qualities. Additionally, it outlines potential risks related to the vehicles themselves from aspects such as maintenance level, vehicle performance, and vehicle specificity, and suggests improvement measures.

Enhancing the internal factors of tracked vehicle drivers and eliminating external factors are key to ensuring safe driving and completing tasks. Although the safety of tracked vehicle operation is influenced by more than just internal and external factors, this paper discusses only a few. However, in actual driving, drivers should strive to enhance their comprehensive driving abilities, continuously accumulate experience, implement detailed practices related to driving, minimize all safety-affecting factors, and establish a solid foundation from the onset of their interaction with tracked vehicles. Accumulating driving experience, developing good driving habits, adhering to operational

procedures, and ensuring safety in driving and training promote development.

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