ANALYSIS OF THE OPERATIONAL EFFICIENCY OF BRAKING SYSTEMS IN MODERN BUSES

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Annotation. *This study analyzes the performance efficiency of braking systems in modern buses. The braking system is one of the most important components that ensures safe vehicle operation. In urban conditions, buses frequently stop and start, which creates high loads on the braking system. Therefore, it is necessary to regularly monitor its technical condition. The study examines key performance indicators of the braking system, including braking distance, deceleration rate, and response time. In addition, the main factors affecting braking efficiency, such as vehicle speed, load level, and road conditions, are analyzed. Modern buses are equipped with electronic braking systems that improve reliability and control during braking. The results show that proper use of the braking system and regular maintenance significantly increase safety and reduce operational costs.*

Key words: *braking system, bus safety, braking efficiency, braking distance, deceleration, response time, technical condition, vehicle speed, load conditions, road conditions, electronic braking systems, maintenance, operational efficiency*

Modern buses play a crucial role in urban and intercity transportation systems. The safety and reliability of these vehicles largely depend on the performance of their braking systems. In urban conditions, buses operate in frequent stop-and-go cycles, which significantly increases the load on braking components. As a result, the efficiency of the braking system becomes a key factor in ensuring road safety and reducing operational risks.

Fig.1. Breaking system efficiency in modern buses

In recent years, advanced technologies such as Electronic Brake System (EBS) and Anti-lock Braking System (ABS) have been widely implemented in modern buses. These systems improve braking performance, prevent wheel lock, and enhance vehicle stability. Therefore, analyzing the efficiency of braking systems and identifying influencing factors is an important scientific and practical task.

The study is based on theoretical analysis, observation, and comparative evaluation of braking system performance in modern buses. Key performance indicators such as braking distance, deceleration rate, and response time were selected as evaluation criteria.

The braking distance was analyzed considering vehicle speed, load conditions, and road surface characteristics. The relationship between braking distance and speed can be expressed as:

$$S = \frac{v^2}{2a}$$

where S is braking distance, v is initial speed, and a is deceleration.

Additionally, the impact of electronic control systems, including EBS and ABS, was evaluated. The condition of braking components such as brake pads and discs was also analyzed to determine their effect on system efficiency.

The findings indicate that braking efficiency in modern buses is determined by a combination of technical characteristics and operating conditions. One of the most sensitive indicators is braking distance. As vehicle speed increases, the stopping distance grows disproportionately, which is consistent with a quadratic relationship between speed and braking distance. In practical terms, this means that even a moderate increase in speed can significantly extend the stopping distance, emphasizing the importance of speed control in urban traffic.

Vehicle load was also found to play a major role. When the bus operates under higher load conditions, its overall mass increases, which in turn raises inertia. This leads to longer stopping distances and reduced deceleration efficiency. Observations show that fully loaded buses require greater braking force and more time to stop compared to partially loaded vehicles.

The technical condition of braking components directly affects system performance. Wear of brake pads and discs reduces the friction between contact surfaces, which negatively impacts braking effectiveness. In situations where maintenance is delayed, both braking distance and system response time increase. In contrast, vehicles that undergo regular maintenance demonstrate more stable and predictable braking behavior.

The role of modern electronic systems is also significant. Technologies such as Electronic Brake System (EBS) and Anti-lock Braking System (ABS) contribute to better force distribution and prevent wheel locking during braking. This improves vehicle stability, especially under challenging road conditions such as wet or slippery surfaces.

Another important observation concerns system response time. Electronically controlled braking systems react faster than conventional systems, which is particularly important in emergency situations where rapid response can prevent accidents.

Overall, the results confirm that braking system performance depends on several interacting factors, including speed, load, road conditions, and maintenance quality. Regular inspection, timely replacement of worn components, and the use of advanced braking technologies are essential for ensuring high efficiency. Improving these aspects can enhance safety, reduce operational costs, and increase the overall reliability of public transport systems.

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