

# HUMAN FACTOR INFLUENCE ON TRAIN BRAKE EQUIPMENT RELIABILITY

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## ABSTRACT

The article considers the human factor influence on trouble-free operation of brake equipment of trains. The study was carried out by an analytical method, based on the statistics of equipment failures, assessment of implementation of the current rules for railway rolling stock maintenance. The

problem of the lack of an effective device for diagnosing the brake network of a train, which would provide control over its integrity and density in the course of traffic and during stops, is revealed. At the same time, it is also necessary to reduce time for measuring density of the brake network, the train to automate this process.

**Keywords:** railway, traffic safety, braking equipment, train brake network density, reliability, human factor.

**Background.** The concept of «human factor» is characterized by extreme variety and complexity. Theoretically, it can include all the phenomena in organization of traffic safety, one way or another connected with a man. Train movement is a functioning of a complex biomachine system, which includes subsystems: a man (locomotive crew), equipment (train), technology, environment (weather, climate) [1].

**Objective.** The objective of the author is to consider the human factor influence on reliability of the brake equipment of the train.

**Methods.** The author uses general scientific and engineering methods, comparative analysis, scientific description, evaluation approach, graph construction.

**Results.** In analyzing the results of scientific research, the practice of locomotive crews, data from search experiments and observations of brake equipment, we constantly have to make sure that proposals for improving safety of train traffic must be fully assessed systematically.

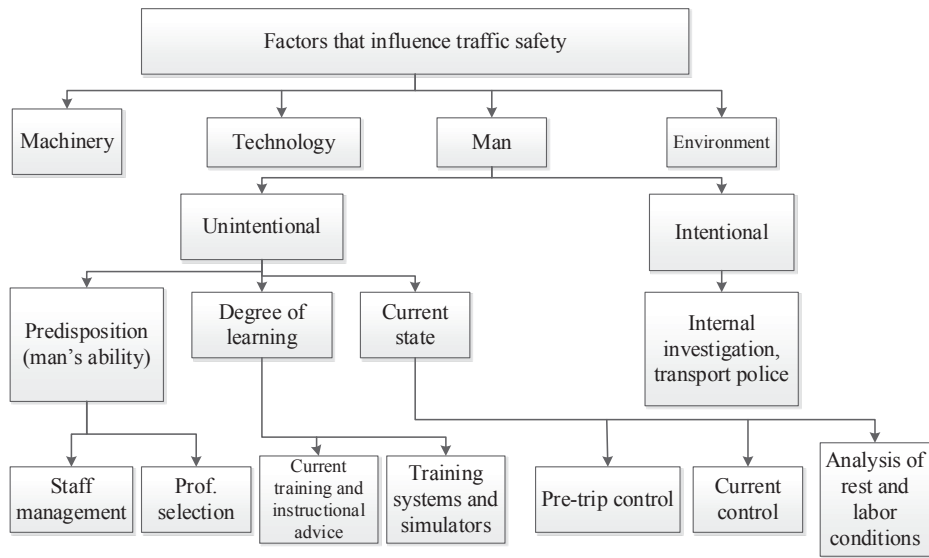
Between efficiency, reliability, performance and other operational indicators of the brake equipment, there are certain relationships, identification of which allows to monitor functioning of the system. However, prevention of accidents and ensuring traffic safety on the move is carried out by the locomotive crew, therefore reliability problems of its actions remain decisive, which was reflected in the generalization scheme shown in Pic. 1.

To ensure traffic safety and reliable operation of brake devices, continuous monitoring by the locomotive crew is required for the state of the entire brake line: from the driver's brake valve to the end valve of the last car in the train.

The principle of operation of pneumatic brakes is that when the pressure in the brake line (hereinafter BL) of the train decreases by the rate of service or emergency braking, each air distributor of the car fills the brake cylinder with compressed air from the reserve tank, and when the pressure in BL increases, it releases compressed air from the cylinder in atmosphere. The train must be stopped within the calculated stopping distance, for which faultlessly functioning brakes are required [2].

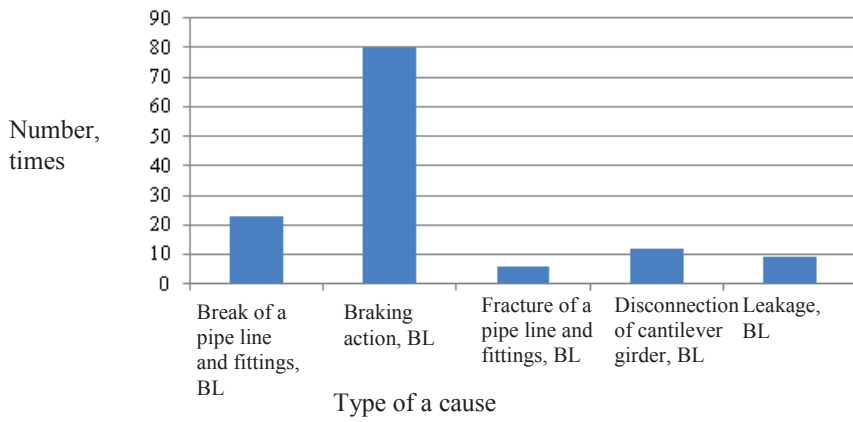
Automatic and electro-pneumatic brakes of railway rolling stock must be kept in accordance with rules and regulations, have controllability and reliability of operation in various operating conditions, ensure smooth braking, and automatic stop of the train when the brake line is disconnected or broken and when the emergency brake valve is opened [3]. The locomotive crew is obliged to monitor the air pressure through manometers, in the absence of such control there is a possibility of unauthorized reduction of the charging pressure in BL, which makes it impossible to stop before the restrictive signal, and this entails a collision or wreck of the train.

Minor malfunctions, leading to spontaneous activation of auto brakes, as well a complete failure

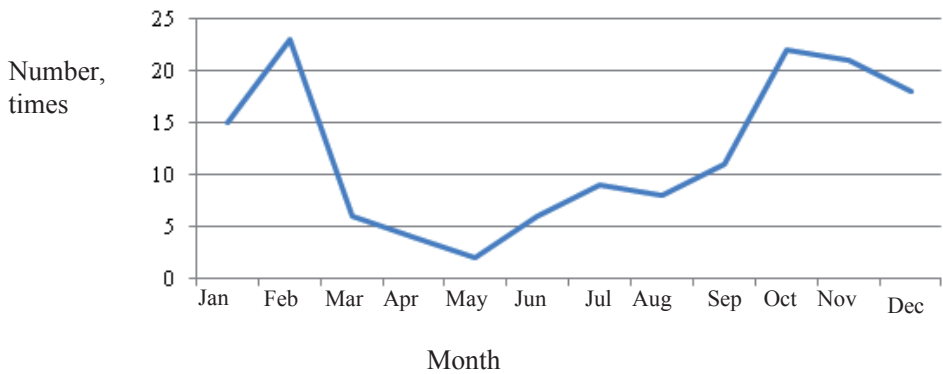


Pic. 1. Factors affecting traffic safety.

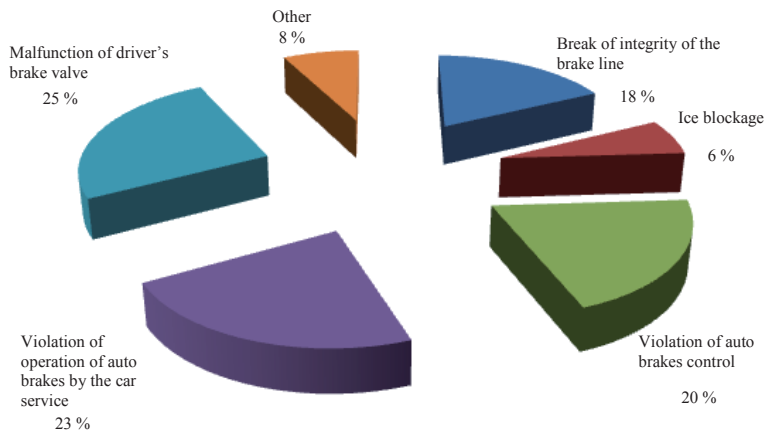




**Pic. 2. Statistics of failures of braking equipment of cars on the East-Siberian Railway for 2015.**



**Pic. 3. Malfunctions of brakes on the East-Siberian Railway on monthly basis.**

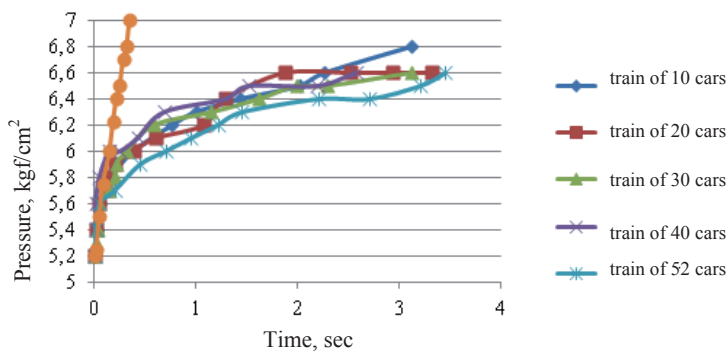


**Pic. 4. Causes of failures of the brake equipment over the last 15 years.**

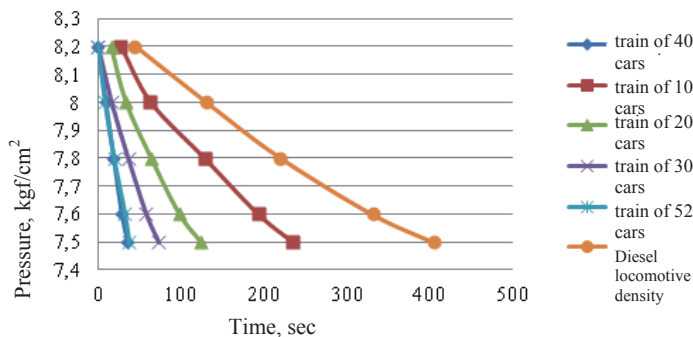
of auto-braking equipment occur. Pic. 2 shows the statistics of failures of braking equipment of cars on the East Siberian Railway (hereinafter referred to as «ESR») for 2015.

Due to the lack of diagnostic devices, most failures of brake equipment – «activation» – occur for unknown reasons. Pic. 3 illustrates the failure of the brakes by months on the ESR.

Obviously, with the onset of low temperatures, the number of failures of brake equipment increases, which demonstrates the importance of taking into account the external environment. And this is despite the fact that before train departure a whole complex of checks is carried out, covering almost every brake device on the rolling stock. Violations arise in the system «man – train – technology – environment» in



**Pic. 5. Overestimation of pressure in BL when setting the handle of the driver's brake valve in the first position.**



**Pic. 6. Increase in the density of the brake network of the train when the end valves with an interval of 10 cars.**



**Pic. 7. Results of measuring the density of freight trains.**

most cases through the fault of a person. The reasons for failures of the brake equipment over the past 15 years are shown in Pic. 4.

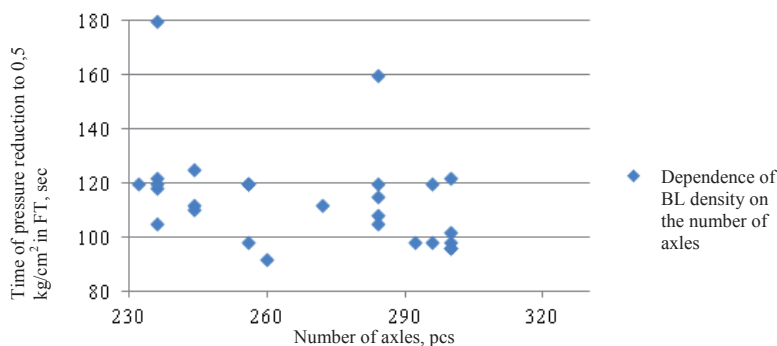
About 90 % of these faults are diagnosed by a train driver with the help of such parameter as density of the brake network. The density of the brake network of the train is time of pressure reduction in the main tanks from 0,85 MPa to 0,8 MPa.

The human factor influences the existing technique for measuring density and diagnostics of the brake network as a whole, this is due to the low precision of the instruments and imperfection of methods for

determining the correctness of the brake equipment. Density is measured by hours, based on the readings of the manometer, the measurement error reaches 40 %. Metering is done many times during the trip.

In accordance with paragraph IV of the «Rules for technical maintenance of brake equipment and brake control of railway rolling stock», the density is measured: with full brake testing, with reduced brake testing, with technological testing of brakes in freight trains, with the acceptance of the driver's brake valve, and also after stop for 300 seconds (5 minutes) or more [4].





**Pic. 8. Dependence of the brake network density on the number of axles of freight trains.**

In order to check the passability of the brake line, the handle of the drive valve is placed in the first position – charging the brake line before departure [4]. The intensity of the overestimation of pressure in the brake line is used to diagnose the closing of the end valves in the train. The interpretation of speed bands and the checking of locomotive crews show that a significant number of workers perform this procedure formally, do not control the readings of manometers. The crash on the haul of Yarał–Simskaya on 11.08.2011 is a confirmation of this.

In the process of studying the problem, an experimental study was conducted to determine the effectiveness of the procedure for placing the driver's brake valve in the first position to check the passability and integrity of the brake line. The data are presented in Pic. 5.

Overlapping of the end valves of the train behind the locomotive, after the tenth, twentieth, thirtieth, fortieth cars was carried out. The graph shows that the overlap of already the tenth car with the help of a regulated test cannot be detected due to the growth of the brake network.

In the course of the experiment, the density of the brake network of the train was measured while overlapping the end valves at an interval of 10 cars, as illustrated in Pic. 6. It can be concluded that the density increases with the overlapping of valves in the train.

In addition, as a result of the experimental trips, density of the freight trains (in the II position of the operating body of the driver's brake valve) in the length of 200 to 250 axes was measured on the service section of Taksimo–Severobaikalsk–Lena service station. The results are shown in Pic. 7. The diagram shows that the density of trains reaches 500 seconds. Such amount of time is not included in the technological process of density measurement and technological operation for processing the train with the issuance of a certificate of the form VU-45 «On providing the train with brakes and their serviceable operation».

Then follows the analysis of the certificates of the form VU-45, obtained in the depot. Pic. 8 depicts the values of the density of the brake network of the train (in the II position of the control body of the driver's brake valve), which correspond to the data of certificates.

The analysis shows that the drivers indicate a fictitious density in the certificate of the form VU-45. This is due to the fact that before each departure of a freight train from an intermediate station or a haul in stop for more than 300 seconds (5 minutes), the driver must check the density of the brake network with a mark on the back of the certificate. If a change of more than 20 % is seen to increase or decrease, the stopping time increases by 500 seconds [4], which does not allow the train schedule, running, technical, precinct, route speed. This is especially true for single-track sections, where stops at stations are the most frequent.

**Conclusion.** The conducted studies confirmed the need to improve the procedure for measuring the density of the brake network of a train, the introduction of modern technical means of control. With development of scientific and technological progress, the influence of the human factor on traffic safety can be minimized, and it is this task at Irkutsk State Transport University the creation of the «Brake Train Network Diagnostics System» is subordinate.

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