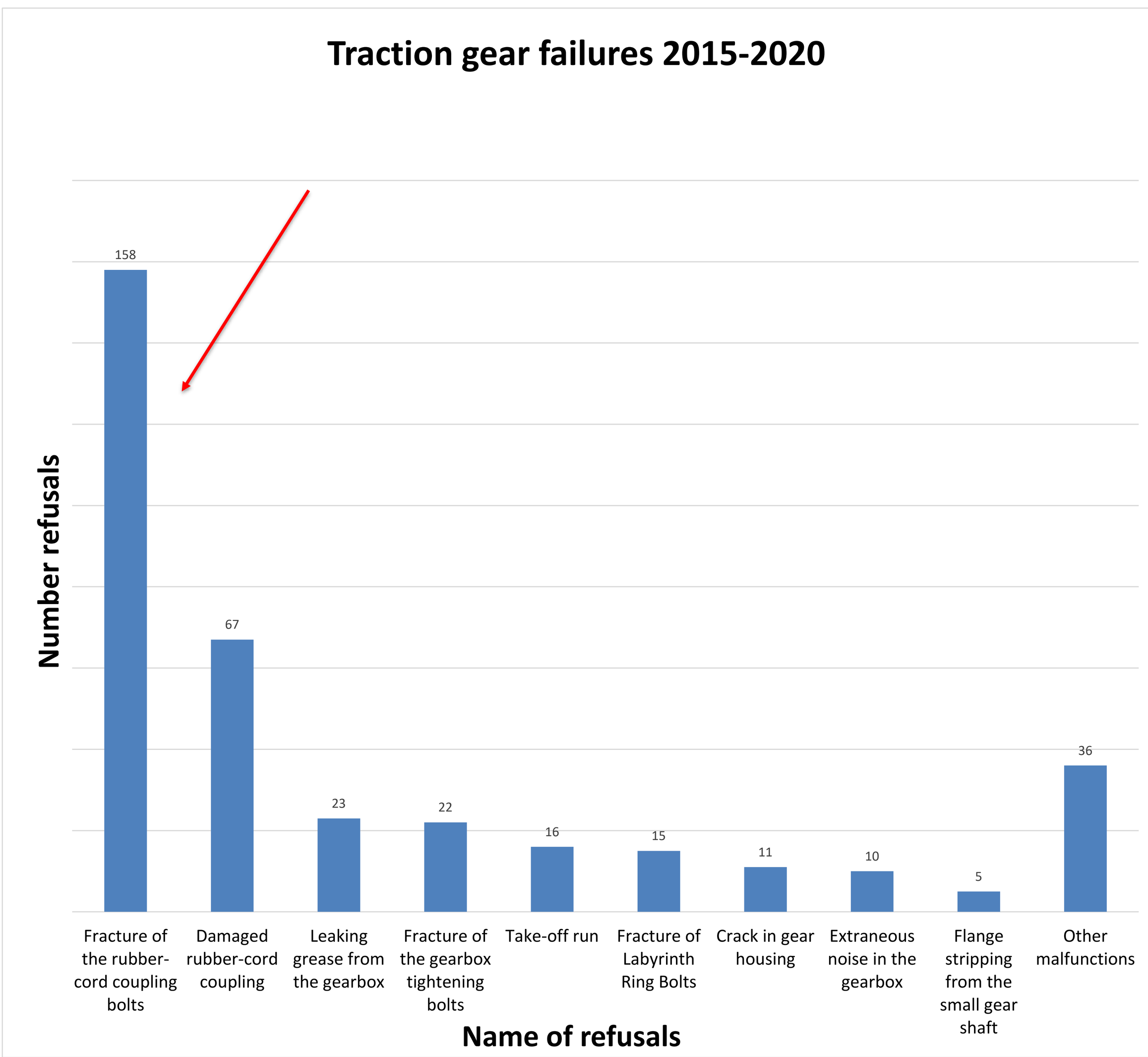
Reducing the number of unscheduled repairs of traction gear of EMU trains by introducing modern technical solutions

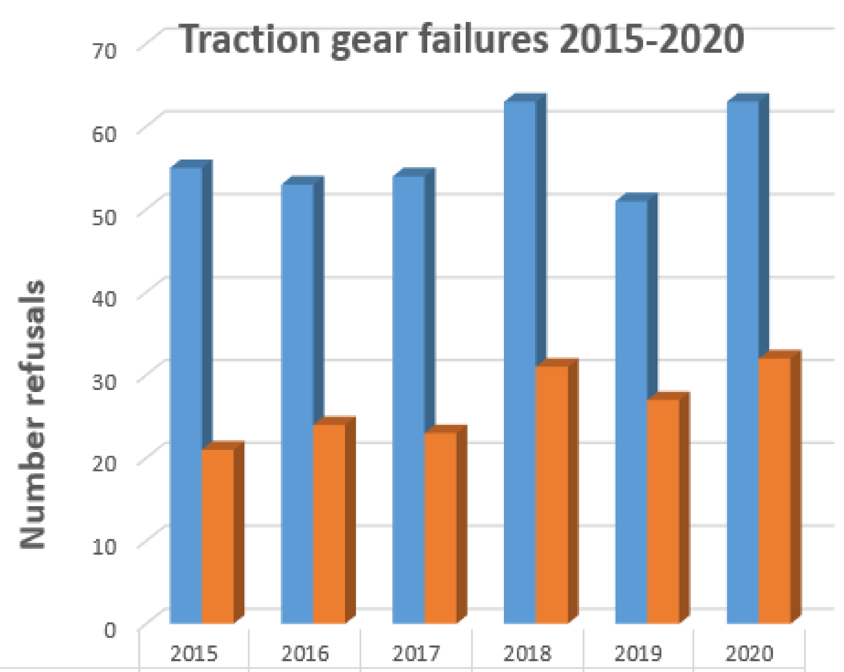
Dmitrijs Gorbachovs, Fjodors Mihailovs, Janis Eiduks.

Riga Technical University, Institute of Transport .

Introduction

The purpose of this article was to find a solution to the problem of reducing the number of the electric multiple unit (EMU) trains traction drive unscheduled repairs due to the breakage of the M24 bolts of the rubber-cord coupling. For these purposes, it is proposed to develop a device that allows accumulating and transmitting data of the impact forces perceived by the bolts of the rubber-cord coupling and whereby reduce the number of unplanned repairs, as well as the associated rolling stock maintenance financial costs for the JSC ”Pasažieru vilciens” railway undertaking. At the JSC “Pasažieru vilciens” company operating on the Latvian Railway, one of the main reasons for unscheduled repairs of EMU trains motor cars traction gears is the brakes of M-24 bolts for fastening the rubber-cord coupling. According to reports. on unscheduled repairs for the period from 2015 to 2020, 358 cases of unscheduled repairs of motor cars due to the malfunction of the traction drive were registered. Of these cases 158 are the braking of the M-24 bolts for fastening the rubber-cord clutch, which consists 44% of the total number of traction transmission faults.





	2015	2016	2017	2018	2019	2020
Total number of unscheduled repairs of traction gear	55	53	54	63	51	63
Number of the rubber cord bolts damage	21	24	23	31	27	32

Methodology

In order to reduce the total number of unscheduled repairs and the use of related financial resources due to the replacement of damaged bolts, it is necessary to ensure permanent devices for the condition of rubber - cord coupling bolts monitoring. To solve the problem of damage to the rubber-cord coupling bolts, it is necessary to develop and implement the following technical solutions:

1. Equipping the rubber-cord coupling flange on the traction motor and gearbox side with 2 shock vibration sensors (4 in total for 1 rubber-cord clutch to control the condition of the rubber-cord coupling and its bolts, with signal transmission to the driver's cab via Bluetooth.
2. The shock vibration sensors can be installed on the rubber cord coupling flange using a threaded connection.
3. The shock vibration sensors can be used to detect the impact load on the bolt connection, as well as to discover the loosening of the rubber-cord coupling nolts.
4. Inviting programmers to develop software and entering the software obtained data into a computer or mobile phone application.

Due to the design features, access to the traction drive during operation and maintenance is complicated, which causes certain problems in determining its technical condition. Therefore, it is necessary to introduce modern system methods and technical control means in order to obtain up-to-date objective data on the serviceability of the traction drive and its fastening bolts M-24.

Results

The prototype of the shock sensor is made on the basis of a primary transducer with a shock acceleration range of up to 20 m/s^2, which is rigidly connected to the metal body of the coupling flange by means of a threaded connection. The contact surface of the housing has a hardness index of HB ≥ 230 and is made in the form of a cylinder. Upon reaching a certain impact force P = 55 * 103 N (62217.2 N - 10%), the piezoelectric sensor 1 is triggered and the signal is sent to microcontroller 2, which is designed for processing the electronic digital signal received from the shock sensor and its further storage in a memory device with subsequent sending of data to the driver's cab or to a mobile application using data transmission unit 4 (Bluetooth) the prototype of the device is shown on fig. 3.

To assess the force of impact on the surface, it is proposed to use devices that convert the value of the acceleration obtained as a result of the impact into the form of an electrical signal. The most common devices for such a transformation are sensors, which use a piezoelectric effect – piezoelectric accelerometers, which convert the impact force into an electrical signal, as a result of which the output current or voltage is the accelerometer output informative parameter. Information from the primary transducer (piezoelectric accelerometer), in the form of an electronic signal, is fed to the microcontroller, in which the information is processed and stored, and then the processed information is transmitted to the data transmission unit. During maintenance or scheduled preventive maintenance the accumulated information is subsequently processed by a tablet computer with installed dedicated software. It shall be also possible to transfer the information using the Bluetooth data transmission system to a computer in the driver's cab or to a mobile device with special application. The schematic diagram of the sensor is shown on Fig. 4.

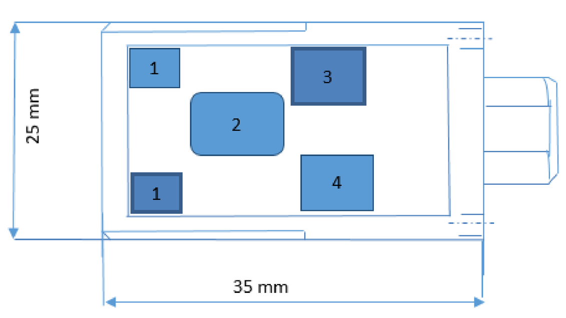


Fig. 3. Impact Sensor Prototype

1 - shock sensor 2 pcs; 2 - microcontroller + memory circuit; 3 - power supply unit; 4 data transmission unit

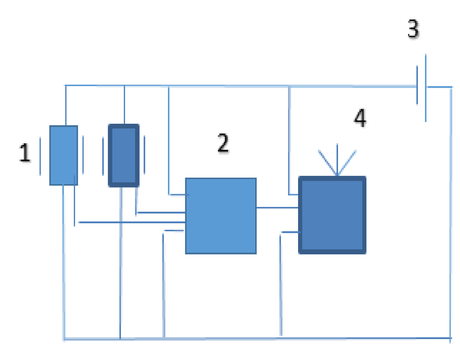


Fig. 4. Att. Schematic diagram of the shock-vibration sensor

1 - shock sensor 2 pcs; 2 - microcontroller + memory circuit; 3 - power supply unit; 4 data transmission unit

CONCLUSIONS:

1. The commissioning of a shock-vibration sensor for monitoring the force of impact will allow obtaining objective information about the force of impact (loads) perceived by the M-24 bolts of the rubber-cord coupling. If, when processing during maintenance (scheduled preventive maintenance)the information received from the sensors, a multiple excess of permissible loads is stated, then in such case, the M24 bolts of the rubber-cord coupling must be replaced with new ones. Thus, the possibility of the need to perform unscheduled repairs due to the breakage of the rubber-cord coupling fastening M-24 bolts, which is associated with large financial costs of the enterprise, is prevented.
2. If the project is successfully implemented with a cost not exceeding 50 thousand euros, then within 5 years the project due to the reduction of the number of unscheduled repairs will come to self-sufficiency, and in 6 years it will already bring a profit of 15 thousand euros.
3. In the long run, the finished product can be offered to European and CIS countries for installation of shock vibration sensors on railway and metros rolling stock , as well as with the perspective of installing the shock vibration sensors on the new EMU trains purchased by JSC «Pasažieru vilciens» In addition, this device can be widely used in mechanical engineering, aircraft construction, shipbuilding and other fields for monitoring and initial determination of the fracture force of bolts.