Justification of the Possibility of Changing of a Permissible Axle Load on the Road

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Abstract. This article includes an analysis of the possibility of changing current axle load and total weight limits for vehicles depending on the type of the vehicle and the season of the year during a transport of goods with modern vehicles. The weighing control has shown exceeding an actual weight and the axle load comparing to the maximum values limited by federal regulations. Ineffective use of a modern heavy vehicles in a transport of goods forces the construction organizations to break the rules of transporting or acquire special permissions. The limitations of the maximum values for the axle load and the total weight are established for the whole calendar period which is incorrect, since the road structure turns into “the monolith” due to freezing in the winter period. This gives a prerequisite to believe that it is required to take into account the seasonal features of the behavior of road structures while imposing maximum limitations established by federal law. An important factor that has a destructive influence on the road construction is not the load or the weight of the vehicle, but a pressure arising in a plane of a tread pattern on a road surface. The destructive influence on the road pavement could be insignificant with a large weight of vehicle and a certain diameter of tread pattern.

1. Introduction

The volume of a transport of goods and passengers is steadily increasing and the road transport is very popular [1,2]. Wherein the composition of vehicles which transport goods is changing towards an increase in a load capacity and a total weight of freight transport what solves the task of transporting large volume of goods traffic as soon as possible.

The possibility of using modern heavy vehicles is limited by the Decree of the Government oh the Russian Federation [3] with the limitation of an axle load and a total weight of vehicle depending on the type of vehicle and the amount of axle according to the load scheme[4]. Meeting the requirements of the limitation of axle loads is directed to the conservation of road construction and its transport-
operational characteristics in the required parameters of security [5, 6]. Values of established axle loads are taken averaged taking into account:

- An amount of applied forces during the rated working life.
- An average total annual rated traffic and the composition of the traffic which is changing significantly during the year.
- A model of transport, reduced to the rated value with ratios.
- A structural strength of the road construction.

According to analysis of an actual data it considers that the established limitation of rated parameter until a certain value does not meet the actual requirements which are formed by several factors (pic.1).

**Figure 1.** Factors that do not meet the actual requirement.

2. **Research**

Certain vehicles used on a practice during the building of capital constructions and civil engineering with a transporting of a large amount of sand-cement and concrete mixes and solid bulk cargoes were chosen for the detailed research of allowable and actual data.

The problem of the prompt delivery of the concrete mix on the construction site becomes relevant with a rapid pace of the construction process. It is important to deliver the required amount of material in time. For the possibility of the preparation of concrete mixes, the reduction in value, the acceleration of the process of mix preparation, the electricity saving the specialized vehicles are used in motion [7]. Frequently the preparation of concrete mix on-site is difficult and unprofitable. In this case mix is bought on the factories which produce general purpose mix or the concrete plant and then transported to the construction site with specialized vehicles.

Auto concrete mixer Volvo FM Truck 8x4 weighing 14,680 tons (picture 2) is commonly used for the transport of concrete mixes of JSC “Mostostroy-11”. When this 4-axis concrete mixer is all loaded with a sand-cement mix, the total weight of the vehicle would be 42 tons. According to appendix №1 of the Russian Federation Government decree [3] weight of four-axis vehicle should not exceed 32 tons. Hence it can be noted that at full load, an excess weight of 10 tons is observed.

Autodumpers is used in construction industry for transportation of bulk cargoes, which are delivered which are delivered to the construction sites [7]. Autodumpers is also used in industrial sectors and agricultural sectors for transportation of harvested crops to elevators and storages, in mining industry for multi-ton volumes of ore from quarries, in utilities industry for waste and precipitation.

JSC “Mostostroy-11” uses three-axis autodumper Volvo FMX 6x4 weighing 14,627 tons and with a loading capacity of 27 tons for transportation inert materials and any bulk cargoes to construction.
sites (picture 3). Exceeding the permissible mass at full load of the three-axle autodumper would be 16 tons.

Figure 2. Four-axis auto concrete mixer Volvo FM Truck 8x4.

Figure 3. Three-axis autodumper Volvo FMX.

The weighing control at the weighbridge stations were done for the assessment of the actual weight and the axle load of vehicles which are used [8, 9, 10, 11, 12]. The identification of the total weight of vehicle and the weight of cargo was carried out with wheel-load scales M8200A [13] at the RMCD (road maintenance and construction department) of JSC “Mostosroy-11”. Many road-construction companies use this type of scales to control the weight of cargoes. Mobile wheel-load scales GZBII were used for the identification of the axle load.

Vehicle passport data, results of the weighing control and permissible values of the weight are presented in the table 1.

Table 1. Vehicle passport data, actual values and permissible values of the vehicles.

| Criteria                                           | Autodumper VOLVO FMX 6x4 | Auto concrete mixer VOLVO FM Truck 8x4 |
|----------------------------------------------------|--------------------------|---------------------------------------|
| Vehicle passport data                              |                          |                                       |
| Weight of vehicle, t                               | 14,627                   | 14,680                                |
| Permissible maximum weight, t                       | 41,000                   | 42,000                                |
| Actual data based on the weighing control          |                          |                                       |
| Actual total weight with all loaded vehicle, t     | 31,170                   | 36,680                                |
| Actual weight on the back axle, t                  | 24,310                   | 10,345                                |
| Permissible values according to the Russian Federation decree |                |                                       |
| Normative total weight, t                          | 25,000                   | 32,000                                |
| Permissible weight on the back axle, t             | 18,000                   | 7,500                                 |

Based on the established parameters the following parameters can be identified:

- Permissible total weight of cargo as the difference between the normative total weight and the weight of vehicle in the vehicle passport.
- Actual weight of cargo as the difference between the actual total weight and the weight of vehicle.
- Excess permissible weight as the difference between the actual total weight and the normative total weight.
- Excess permissible weight on the back axle as the difference between the actual weight and the permissible weight on the back axle.

Result of calculation are presented in the table 2.
Table 2. Results of calculation.

| Criteria                                      | Autodumper VOLVO FMX 6x4 | Auto concrete mixer VOLVO FM Truck 8x4 |
|----------------------------------------------|--------------------------|---------------------------------------|
| Permissible total weight of cargo, t         | 25,000 - 14,627 = 10,373 | 32,000 - 14,680 = 17,320              |
| Actual weight of cargo, t                    | 31,170 - 14,627 = 16,543 | 36,680 - 14,680 = 22,000              |
| Excess permissible weight, t                 | 31,170 - 25,000 = 6,170  | 36,680 - 32,000 = 4,680               |
| Excess permissible weight on the back axle, t| 24,310 - 18,000 = 6,310  | 10,345 - 7,500 = 2,845                |

According to the results of measurements at the weight control post in comparison with the allowed loads we can conclude that there is excess axle load almost 1.35 times for each. The total weight is significantly exceeded by 6,170 tons for the autodumper and 4,680 tons for the auto concrete mixer. Therefore the transporter must load the vehicle with lower amount of cargo which suits the normative values of the axle load and the total weight of vehicle. This will lead to ineffective using of the vehicle, it means that the vehicle would not provide the transporting of the amount of cargo which is permissible according to the vehicle passport characteristics.

3. Conclusion

Requirement to limit the axle load and the permissible weight of vehicle makes road-construction companies with huge heavy vehicle fleet:
- Use vehicles with 50% load from the maximum possible load capacity wherein consume fuel and exhaust service life of transport unit.
- Acquire and use other vehicles with lower load capacity.
- Acquire special permissions [14, 15].
- Regularly pay a penalty [16].

Level of damage from vehicles is calculating on the normative working time with an influence on the road construction calculated on elastic deflection for the period of positive temperature. The influence on the road construction from heavy vehicles cannot be similar in the period of negative temperature [17]. The road construction with negative temperatures becomes a “monolith” which can sustain heavier loads and cannot be destroyed the similar way it can be in the summer period. The application of the seasonal level of restrictions on highways is possible on the sites with regard to the repairs carried out, including the installation of an additional layer of the road pavement.

During the period of stable negative temperatures, when freezing of road construction and the roadbed is ensured, as a general monolithic, as well as in the summer period, the principle of limiting the axle load with the calculation of the impact on the condition of asphalt and concrete surfacing. The abolition of this principle for the winter period would provide the possibility of transportation of goods by high-capacity vehicles and an increase in the number of deliveries, in particular, of road construction materials to road construction objects. It would also reduce construction time, which will double the volume of construction.

An important factor of distraction of the road construction will be the pressure arising in a plane of a tread pattern on a road surface [18], but not the weight of vehicle or the axle load. Nowadays the pressure 0.8 MPa for the roads with capital type of the road construction (axle load 115 kN) and the pressure 0.6 MPa for the roads with lightweight or transitional types of the road construction (axle load 100 kN) are established for the normative loads [19, 20, 21]. It needs to identify actual pressure of a tread pattern on a road surface which is made by the modern vehicles for the assessment of the influence of necessary load. It predetermines the necessity of the additional measurements.

Taking into account these factors and initial requirements for calculating restrictions on roads for the effective organization of work performed by vehicles, it is proposed to differentiate the application
of restrictions on the seasonal basis, with an additional assessment of the road pavement condition, as well as the object of implementation geographical location.

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