Investigation of power, mass-dimensional parameters of trucks with full weights in the region of 6 and 15 tons

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Abstract. The article considers the analysis of the parameters of advanced urban trucks with a gross weight of 6 and 15 tons. The advantages and disadvantages of existing vehicle designs of analogues are analyzed. Recommendations are made regarding the design of the vehicle’s carrying system, cab, steering, suspension. It is concluded that driver assistance systems should be included in the basic configuration. A table with advanced vehicle parameters is given.

1 Introduction

Wheeled vehicles account for more than 70% of the total number of transport and technological vehicles (TTV). The wheel propulsor [1] is the most common traction and support system that is used on the TTV. Among the variety of wheeled vehicles, the most common are vehicles with a 4x2 wheel formula. The scope of their application is vehicles for the transportation of passengers, as well as the transportation of goods in urban conditions, and, in addition, on roads with improved road surface.

It is in urban conditions that the use of light commercial vehicles with a 4x2 wheel formula is conditioned due to the fact that they have sufficient load capacity along with maneuverability, economy and other advantages [2, 3]. The use of such machines is typical for solving problems of small and medium-sized businesses related to the transportation of goods within the limits of a settlement or between cities. The vehicle is suitable for use in urban mode [4], but behaves well in off-road conditions. As part of this study, we will consider vehicles with full weights in the region of 6 and 15 tons. Let's analyze the power and mass-dimensional parameters of trucks with a 4x2 wheel formula. We will give recommendations to the parameters of the most competitive vehicle.
2 Overview of trucks with full weights in the region of 6 and 15 tons

As part of the review, trucks that can compete with cars with a gross weight of 6 and 15 tons in terms of their technical characteristics were considered. In addition to the total weight of the vehicles, engine power, load capacity, turning radius, ground clearance, front and rear approach angles, suspension type, tire size were considered.

2.1 Vehicles with a gross weight of 6 tons

As part of the review, the following trucks with a gross weight of about 6 tons (T-6) were considered:
- JAC N56 (Manufacturer China First Automobile Group Corporation);
- FAW CA1041 (Manufacturer JAC Motors);
- Foton S85 (Manufacturer DAF Trucks NV);
- DAF LF 45 (Manufacturer Beiqi Foton Motor Ltd);
- ISUZU ELF 5.5 (Manufacturer Isuzu Motors Ltd);
- Hyundai HD35 (Manufacturer Hyundai Motor Company);
- Валдай NEXT (Manufacturer ООО "Автозавод "ГАЗ").

Figure 1 shows the vehicles studied.

![Truck analogues](image)

**Fig. 1.** Truck analogues. a- JAC N56 [5]; b- FAWCA1041 [6]; c - Foton S85 [7]; d - DAF LF 45 [8]; e - ISUZU ELF 5.5 [9]; f - Hyundai HD35 [10]; g - Valdai NEXT [11]

For the vehicles considered, the operating conditions, advantages and disadvantages of the design were analyzed, based on which conclusions were drawn about the recommended characteristics of an advanced and competitive vehicle.

2.2 Vehicles with a gross weight of 15 tons

As part of the review, the following trucks with a gross weight of about 15 tons (T-15) were considered:
- JAC N120 (Manufacturer JAC Motors);
- FAW CA1083 (Manufacturer China First Automobile Group Corporation);
- Foton S120 (Manufacturer Beiqi Foton Motor Ltd);
- ISUZU FORWARD 12.0 (Manufacturer Isuzu Motors Ltd);
- Hyundai Mighty EX9 (Manufacturer Hyundai Motor Company);
- KAMAZ COMPAS 43089 (Manufacturer PJSC KAMAZ);
- GAZon NEXT 10 (Manufacturer OOO "Automobile plant "GAZ ").

Figure 2 shows the vehicles studied.

![Image of vehicles]

The parameters under consideration were also analyzed for these vehicles. Further, the advantages and disadvantages of the design of the selected vehicles were analyzed.

### 3 Analysis of advantages and disadvantages

Based on the considered characteristics, it can be concluded that:

1) The vast majority of the presented models of trucks – analogues T-6 and T-15 – have a cab over engine cab. The vehicle turns out to be more compact and roomy and provides a better overview.

   Additionally, the cabin must meet the requirements of safety and comfort. From the point of view of security, this is the fulfillment of the requirements of the UNEC No. 29. An analysis of existing cabins showed that most cabins meet the requirements of No. 29.2, while the advanced (most competitive) cabin meets the more complex requirements of No. 29.3.

   Comfort can be provided by the following solutions: the installation of a cab springing system, which is not advisable for vehicles of this class, as well as the installation of more comfortable seats. For heavier vehicles, it is possible to install a higher roof and a larger sleeping place. In this case, there are not only seats with a springing system, but seats with larger adjustments. This is a necessity for the Russian market, since most of the considered analogues were originally designed for the Asian market. In other words, a typical Russian driver will be cramped.

2) The only requirement will be to ensure the necessary traction and speed indicators, for example, a maximum speed of about 110 kmph and the angle of ascent, as well as stability at low temperatures.

3) An analysis of the operating conditions, positive and negative reviews of analog cars allow us to conclude that the vehicle frame must be carried out with some margin of safety, since in practice trucks are constantly operating in overload mode. This can be achieved by...
using stronger materials than the materials of prototypes. At the same time, the frame design should be unified as much as possible, regardless of the type of power plant. A permanent profile frame is more technologically advanced – it can be manufactured without significant re-equipment of production.

4) For the GA-6, it is necessary to use a less rigid suspension, for example, a few-leaf suspension. It will also reduce the material consumption.

5) To ensure better maneuverability in cramped road conditions, it is necessary to increase the rotation angles of the front wheels. This will provide smaller turning radii.

6) Increasing safety requirements demand the use of reinforced braking mechanisms. An analysis of the designs of analogues, along with the requirements for reducing unsprung masses, allows us to conclude that disc reinforced brakes should be installed on vehicles. It is advisable to make the brake drive pneumatic.

7) Russian operating conditions allow us to conclude that the ground clearance of vehicles should be as large as possible.

8) Along with the mechanical part, the vehicle must have driver assistance systems, such as: stability control system (ESP), braking force redistribution system (EBD), lifting assistance system (HSA) and anti-slip system (ASR). These systems must be available in the basic configuration.

4 Conclusion

Based on the analysis of the vehicles of the T-6 and T-15 analogues, the proposed parameters of advanced vehicles will be the following, indicated in Table 1.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>T-6</th>
<th>T-15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheel configuration</td>
<td>4x2</td>
<td>4x2</td>
</tr>
<tr>
<td>Total weight of the vehicle with axles/axles separation, kg:</td>
<td>6000</td>
<td>15000</td>
</tr>
<tr>
<td>- for the front axles, kg</td>
<td>2250</td>
<td>5000</td>
</tr>
<tr>
<td>- for rear axles, kg</td>
<td>3750</td>
<td>10000</td>
</tr>
<tr>
<td>Power on the drive axle, kW</td>
<td>84</td>
<td>148</td>
</tr>
<tr>
<td>Maximum speed at full weight, kmph</td>
<td>110</td>
<td>110</td>
</tr>
<tr>
<td>Front entrance angle, degree</td>
<td>27°</td>
<td>22°</td>
</tr>
<tr>
<td>Ground clearance, mm</td>
<td>205</td>
<td>220</td>
</tr>
<tr>
<td>The approach angle to be overcome on dry asphalt, %</td>
<td>39</td>
<td>30</td>
</tr>
<tr>
<td>Steering Formula</td>
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<td>1-0</td>
</tr>
</tbody>
</table>

5 Acknowledgments

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