Development of KORSAK 8x8 small-size all-terrain vehicle design project

A G Kapustin¹, A V Papunin and A M Belyaev

Nizhny Novgorod State Technical University n.a. R.E. Alekseev, Minin str., 24, 603950, Nizhny Novgorod, Russia

E-mail: ¹kapustinalexandr2017@yandex.ru

Abstract. The paper presents KORSAK 8x8 Small-Size All-Terrain Vehicle Design Project developed in Nizhny Novgorod State Technical University n.a. R.E. Alekseev. Performance specifications of the vehicle non-inferior to those of the existing similar vehicles. This all-terrain vehicle has better ergonomics and visibility from the driver seat. The cabin design of the vehicle complies with the requirements of the applicable Codes and can be certified for use in the Russian Federation. For inspection of the aesthetic properties of this all-terrain vehicle, a 1:5-scale dummy was made.

Introduction
For the time being, there is a considerable interest, in terms of scientific research and practical use, in manufacturing of highly-efficient small-size light land-based vehicles. The use of light all-terrain vehicles allows for lower operation costs and a possibility of easy driving over heavy-going terrain impassable for heavy all-terrain vehicles. Korsak 8x8 snow and swamp-going vehicle currently under design in Nizhny Novgorod State Technical University n.a. R.E. Alekseev (NNSTU) has a high level of all-terrain capacity and environmental friendliness of the propulsion unit due to low ground pressure, being intended for carriage of passengers and cargo in absence of roads, including on virgin snow, swamped terrain, open water basins and quick sand. Previously, the authors hereof have developed Korsak 6x6 All-Terrain Vehicle [1, 2]. Tests were made for flotation and drive path profile capacity, as well as for swimming [3-6]. Under recognition of the available backlog, the all-terrain vehicle presented in the paper has better mobility performance.

Project description
Conducted polling and its subsequent analysis have shown that would-be buyers of all-terrain vehicles of this class want to possess a vehicle complying with the following requirements: an engine above 25 kW; ride comfort; availability of useful cargo space; availability of a safety framework; availability of side rear-view mirrors; the vehicle shall feature individually-shaped body; a multimedia system shall be installed in the basic configuration.

Figure 1 shows the exterior appearance of Korsak 8x8 All-Terrain Vehicle meeting the declared requirements.
Figure 1. KORSAK 8x8 Small-Size All-Terrain Vehicle

For concise technical specifications of KORSAK 8x8 All-Terrain Vehicle see Table 1.

Table 1. Basic specifications of KORSAK 8x8 All-Terrain Vehicle

| Specifications                                      | Value                        |
|----------------------------------------------------|------------------------------|
| Gross vehicle weight (GVW), kg                      | 1200                         |
| Load carrying capacity, kg                         | 400                          |
| Design version:                                    |                              |
| 1) passenger version;                              |                              |
| 2) cargo version;                                  |                              |
| 3) cargo-and-passenger version                      |                              |
| cabin                                              |                              |
| engine compartment                                 |                              |
| Number of passenger seats                          | 2-7 (dependent on the design version) |
| Average ground pressure with full load, MPa (kgf/cm²) | 0.025 (0.25)                 |
| Engine                                             | Lifan 2v90 (37 h.p.)         |
| Overall length/ width/ height, mm                  | 3375/ 1600/ 1900             |
| Track width, mm                                    | 1320                         |
| Wheel base, mm                                     | 2250                         |
| Road clearance, mm                                 | 300                          |
| Weight of towed trailer, kg                        | 400                          |
| Max. travel speed, km/h                            | 50/ 5                        |
| on-road/ swim                                      |                              |
| Road clearance, mm                                 | 300                          |
| Obstacles bridged:                                 | 35° / 25°                    |
| ascend (descend)/ flank slope                      |                              |
| Transmission:                                      |                              |
| 1) mechanical;                                     |                              |
| 2) hydrostatic;                                    |                              |
| Turning control                                    | Motorcycle-type handlebar, power turn |
| Propulsion unit:                                   | 8x8 wheel formula, low-pressure tires, |
|                                                     | tire dimensions 25"-12.5"-10" |
| Body                                               | Carrier frame - self-carrying, steel, |
|                                                     | water-tight. Body - glass-fiber |
|                                                     | reinforced plastic. Safety framework. |

The vehicle configuration can be different and depends on the required number of passengers and cargo quantity. Figure 2 shows different arrangement layouts of the passenger seats.
Figure 2. Configuration variants of KORSAK 8x8 All-Terrain Vehicle: 
a – two-seat, b – three-seat, c, d – four-seat, e, f – five-seat, g – seven-seat.

This all-terrain vehicle has better ergonomics and visibility from the driver seat than the existing similar vehicles. Fig. 3 shows the visibility from the driver and the passenger seats during boarding, as shown in Figure 2 c. The boarding of the driver and the body frame of the all-terrain vehicle is designed in a manner to meet the requirements of the visibility in accordance with the applicable codes.

Figure 3. Visibility form driver and passenger seats
Also, safety framework calculations were made for compliance with GOST R 50943-2011. The structure shall withstand the design impacts imitating the capsizing of the snow and swamp-going vehicle. It is exactly the loading of the front and side edge of the cabin roof with a test loading device at displacements of 5° in longitudinal, and 25° in transversal directions. The load produced by the loading device makes 1.5 of the vehicle weight. Fig. 4 shows the framework of the vehicle in the deformed state.

![Figure 4. Load accommodation diagram by the design model and appearance of the deformed framework](image)

The obtained calculation results demonstrate, that the framework deformation in the vertical direction is 196 mm and does not exceed admissible values and may be certified for use in the Russian Federation.

**Result and discussion**

The paper presents a description of a design project developed in Nizhny Novgorod State Technical University n.a. R.Ye. Alekseyev of KORSKA 8x8 Small-Size All-Terrain Vehicle being a descendant of previously designed 6x6 chassis. It is demonstrated that the new vehicle has better specifications than existing similar vehicles and complies with the anticipations of would-be buyers of all-terrain vehicles of such class. Different configuration variants are presented dependent on the arrangement and the number of the passenger seats. The visibility from the driver and the passenger seats is shown. Calculations demonstrate that the developed safety frame complies with GOST R 50943-2011, and the all-terrain vehicle may be certified in Russia.

The following design stage will be creation of mathematical models for 8x8 vehicles with low-pressure tires [5-8], calculation of mobility parameters over virgin snow [7-11], and the assessment of the efficiency of their use for carriage of goods and passengers in the given conditions.

**Acknowledgment**

This study was conducted in continuation of the research conducted by "Nizhny Novgorod scientific and practical school of snow vehicles" and with financial support of the grant of the President of the Russian Federation No. MD-226.2020.8.

**References**

[1] Kapustin A G et al. 2019 Development of design project of mini cross-country vehicle KORSAK IOP Conference Series: Materials Science and Engineering 695(1) 012026 doi: 10.1088/1757-899X/695/1/012026

[2] Papunin A V et al. 2018 A dynamic model of unsupported pit traversal by a vehicle with 6x6 wheel arrangement IOP Conference Series: Materials Science and Engineering 386(1) 012001 doi: 10.1088/1757-899X/386/1/012001
[3] Papunin A V et al. 2018 Calculation of trench width to be overcome by multi-axis wheeled vehicle
IOP Conference Series: Earth and Environmental Science 194(6) 062027 doi: 10.1088/1755-1315/194/6/062027

[4] Papunin A V et al. 2019 Field research of profile trafficability of 6×6 wheel assembly KORSAK vehicle
Journal of Physics: Conference Series 1177(1) 012051 doi: 10.1088/1742-6596/1177/1/012051

[5] Belyakov V et al. 2015 Multifunctional vehicle for coastal areas 12th International Conference
on the Mediterranean Coastal Environment, MEDCOAST 2015 pp 945-951

[6] Belyaev A et al. 2019 Development of 8×8 all-terrain vehicle with individual wheel drive VEHITS 2019 - Proceedings of the 5th International Conference on Vehicle Technology and Intelligent Transport Systems pp 556-561

[7] Anikin A et al. 2017 Calculation of traction capabilities of wheeled vehicles on low-pressure tires
on snow 19th International and 14th European-African Regional Conference of the ISTVS

[8] Makarov V, Zeziulin D and Belyakov V 2014 Prediction of all-terrain vehicles mobility in snowscape scenes Paper presented at the 18th International Conference of the ISTVS

[9] Porubov D et al. 2017 Study of efficiency of using all-terrain vehicles during the winter period
19th International and 14th European-African Regional Conference of the ISTVS

[10] Kurkin A et al. 2017 Ground vehicle for ice conditions monitoring 13th International MEDCOAST Congress on Coastal and Marine Sciences, Engineering, Management and Conservation, MEDCOAST 2017 2 pp 827-838

[11] Goncharov K O, Belyakov V V and Makarov V S 2018 Estimating method of efficiency of wheel chassis driving on snow IOP Conference Series: Earth and Environmental Science 194(3) 032005 doi: 10.1088/1755-1315/194/3/032005