Analysis of the diagrams and main parameters of the existing structures of the articulated tracked vehicles

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Abstract. The articles reviews structures of the existing all-terrain articulated tracked vehicles (ATV). It includes the existing classification of the ATVs by the type of pivot coupling mechanism (PCM). It analyses the vehicles produced by the principal manufacturers of ATV available on the Russian market. It offers statistical dependencies for the main relationships of the basic power, dimensional characteristics as well as ground pressure depending on the ATV gross weight. It presents a block diagram of the method of rational selection of the vehicle type, maneuverability control system, provision of the total required power, capacity, maximum travel speed.

Introduction
The functional tasks performed by the transport-technological and special vehicles in certain branches of real economy as well as operational-tactical missions of the special and law-enforcement agencies in most cases are linked with operation on temporary roads or off-road.

The emerging energy-packed multi-operational vehicles allow for mechanization of most works in the forestry, agricultural, oil-gas and mining industries as well as other branches of the national economy and security. Employment of articulated transport-technological systems is one of the promising lines in solving many tasks evolving during operation of the transport and technological complexes under off-road conditions and especially during winter and muddy seasons as well as other specific conditions of their functioning.

An articulated tracked vehicle (ATV) is a special case of an articulated transport system (ATS) [1]. The latter concept is very wide and includes a range of transport and technological vehicles as well as transport-technological complexes featuring at least two hinged sections with one or more degree of freedom.

Today there are no many technical and specialized publications which describe ATV. First of all they are the publications produced by the manufacturers of this type of vehicles [2,3]. There is a number of thesis researches dedicated to ATV [4–6]. Some aspects concerning selection of parameters of the running gear of those vehicles are presented in the works [7, 8].

ATV classification
The number and location of the coupling hinge points [9] (Fig. 1) are taken as a basis for the ATV classification.
Figure 1. ATV classification [9]: I — one-hinged symmetrical (towed) ATV, II — one-hinged saddle-type ATV, III — two-hinged (wagon-type) ATV, IV — two-hinged ATV with intermediate member [9]

Today there are few diagrams of ATV presented in Fig. 2 [2]. Each of those options has its advantages and disadvantages. This article reviews approaches to selection of rational parameters of ATV at an early designing stage.

Figure 2. Diagrams of known ATVs: a — one-hinged towed ATV, b — one-hinged saddle-type ATV, c — towed (platform) ATV, d — bolster-type two-hinged (wagon-type) ATV [2]
Reviews approaches to selection of rational parameters of ATV at an early designing stage
Curvilinear motion of this class vehicles is performed with use of: a pivot-coupling mechanism (PCM) or a pivot-saddle mechanism (PSM). The first type of a pivot mechanism shall provide for jackknifing of elements in three planes: horizontal, longitudinal vertical (modes: shock-absorbers; forced jackknifing; locked state), lateral vertical. The PCM design is much dependent on the designer's preferences, dimensions, ATV requirements to profile passability, design limitations.

When designing articulated transport means, one should be guided by the practice of designing of the existing vehicles. Today the main manufacturers of this type of vehicles are as follows (Fig. 3): JSC MK Vityaz, Zavolzhsky Plant of Tracked Tractors, CJSC Transport, LLC All-Terrain Vehicle Plant, LLC TransMash, LLC EZSM Continent, Foremost Industries LP (Canada), AB Haegglunds (Sweden).

![Figure 3. Main manufacturers of ATV](image-url)

Analysis of parameter processing of the main characteristics of ATV
From the analysis of parameter processing of the main characteristics of ATV we have obtained dependencies and made conclusions about relationship between the capacity and the engine power and travel speed.

Fig. 4 shows that the points are grouped characteristically. 3 groups can be distinguished: 1 - one-hinged ATV, 2 — two-hinged ATV, 3 — special purpose ATV (perform wide range of technological and special operations). Basing on those dependencies we can select vehicle's parameters [10].

In the course of the research we have also obtained statistical dependencies to find speed parameters of the ATV presented in Fig. 5.
Figure 4. ATV parameters dependence on gross weight: a — engine power, b — engine power-to-weight ratio, c — capacity, d — average ground pressure

Figure 5. Travel speed dependence on ATV weight
Proposed block diagram of the method of rational selection ATV pivot-coupling mechanism

Figure 6 shows a block diagram of the method of rational selection of parameters of the ATV pivot-coupling mechanism. Lengths of parts of PCM, location of a hinged point of turn relative to PCM center, location of a vertical jackknifing hinge, etc. (in accordance with Fig. 6) are found as a result of task solving consisting in finding rational parameters which provide for required vehicle mobility factors [11, 12], including: ATV passability, maneuverability, smooth ride and efficiency. With that it is proposed to use special mathematical models given in the works [1-10, 13-21] which describe variable operation conditions of the transport-technological vehicles, including ATV. The obtained parameters serve as initial data for finding parameters of the hydro cylinders of turn (depending on required drawbar pull at turns) and hydro cylinder of vertical jackknifing and estimating hydraulic equipment, PCM frame layout.

Fig. 6. Block diagram for selecting ATV parameters

Conclusion

Thus, the general ATS design solutions determine selection of a type of ATV, PCM and PSM systems, diagrams of power distribution by modules, provision of required power, capacity, maximum travel speed that dictates mobility, output and efficiency of ATS.

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