Experimental evaluation of traction and coupling properties of terrain vehicles

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Abstract. The article demonstrates the results of the experimental evaluation of the traction and coupling properties of the wheeled utility terrain vehicles (UTV) during which parameters and indicators allowing for their use during designing of new generation UTVs are determined. This work demonstrates the results of the tests in determining maximum drawbar pull; determining maximum drawbar pull at snatch load of the Russian-made UTVs RM 650-2, Stels 800 Guepard and foreign-made UTVs Yamaha Grizzly, BRP Outlander Max XT, BRP Outlander 6x6, Polaris Sportsman 1000 equipped with wheels with grouser height of 15 to 40 mm.

1. Place of test
The tests to determine UTV traction and coupling properties were conducted at a test range of Mytishchi branch of the Bauman Moscow State Technical University at the horizontal terrain sections with the maximum slope of 1%.

The test site is coated with asphalt.

The tests were conducted in dry windless weather at an ambient temperature of plus 10ºС, atmospheric pressure of 751 mm Hg and air relative humidity of 65 % [1, 2, 3].

2. Measuring equipment
Weight measuring strain gauge С2-5.0-C3 and digital tension gauge ZET [4] were used as measuring instruments to determine the UTV traction and coupling properties including maximum drawbar pull and UTV motion resistance force.

Digital dynamometer С2-5.0-C3 represents a stain gauge-based device. The strain gauge is connected in series with the power diagram. Dynamometer С2-5.0-C3 is composed of a weight measuring strain gauge working in tension and compression, a secondary measuring converter and a connecting cable. Model ZET is used in dynamometer as a secondary measuring converter.

Dynamometers with measuring terminal ZET operating through interface ZET 7174 converter are delivered with software ZETLAB used to present those measurements in the form of real-time measurement process charts.

Dynamometer С2-5.0-C3 is designed to measure tension force (with upper measurement limit of 50 KN, accuracy class 2 according to GOST P 8.726-2010).
3. Determining UTV maximum drawbar pull

The maximum drawbar pull was determined for the Russian-made UTVs RM 650-2, Stels 800 Guepard and foreign-made UTVs Yamaha Grizzly, BRP Outlander Max XT, BRP Outlander 6x6, Polaris Sportsman 1000 equipped with wheels with grouser height of 15 to 40 mm.

The maximum possible drawbar pull of the UTV (within the pull force margins) was determined with the CVT being in first gear range. A cable with a dynamometer stain gauge was in a pre-tension state, with that a driver of the tested UTV was accelerating and increasing the engine RPM till the wheeled running gear started slipping and then slowly applying brakes [5, 6, 8].

The results of the UTV drawbar pull measurement are presented in Table 1.

| No. | UTV                  | wheel grouser height, mm | Maximum drawbar pull, N |
|-----|----------------------|--------------------------|-------------------------|
| 1   | RM 650-2             | 20                       | 6,190                   |
| 2   | Stels 800 Guepard    | 30                       | 5,370                   |
| 3   | Yamaha Grizzly       | 15                       | 3,460                   |
| 4   | BRP Outlander Max XT | 20                       | 3,831                   |
| 5   | BRP Outlander 6x6    | 15                       | 8,710                   |
| 6   | Polaris Sportsman 1000 | 40                   | 4,183                   |

The analysis of the presented in Table 1 data demonstrates that the Russian-made UTV RM 650-2 (engine power 42.5 h.p.) develops higher drawbar pull than equal in power foreign-made vehicles BRP Outlander Max XT (engine power 48 h.p.) and Yamaha Grizzly (engine power 48 h.p.), and exceeds them by 32 to 45%. The Russian-made vehicle Stels 800 Guepard (engine power 67 h.p.) exceeds Polaris Sportsman 1000 vehicle (engine power 85 h.p.) in maximum drawbar pull by 22%. This can be explained by better hitch weight implementation in the Russian models.

Fragments of UTV tests to determine maximum drawbar pull are presented in Figure 1.
4. Determining UTV maximum drawbar pull at snatch load

The maximum drawbar pull at snatch load was determined for the Russian-made UTVs RM 650-2, Stels 800 Guopard and foreign-made UTVs Yamaha Grizzly, BRP Outlander Max XT, BRP Outlander 6x6, Polaris Sportsman 1000 equipped with wheels with grouser height of 15 to 40 mm.

The UTV maximum drawbar pull at snatch load was determined with the CVT being in first gear range. A cable with a dynamometer stain gauge was stowed, with that a driver of the tested UTV was accelerating from zero over a distance of 15 m until a cable gets fully strained (till snatch) and then slowly applying brakes [7].

The results of the UTV drawbar pull measurement at snatch load are presented in Table 2.

| No. | UTV                        | wheel grouser height, mm | Maximum drawbar pull, N |
|-----|----------------------------|--------------------------|-------------------------|
| 1   | RM 650-2                   | 20                       | 17,490                  |
| 2   | Stels 800 Guopard          | 30                       | 16,090                  |
| 3   | Yamaha Grizzly             | 15                       | 13,777                  |
| 4   | BRP Outlander Max XT       | 20                       | 14,139                  |
| 5   | BRP Outlander 6x6          | 15                       | 20,038                  |
| 6   | Polaris Sportsman 1000     | 40                       | 15,416                  |

The Russian-made UTV RM 650-2 (engine power 42.5 h.p.) develops higher drawbar pull at snatch load than equal in power foreign-made vehicles BRP Outlander Max XT (engine power 48 h.p.) and Yamaha Grizzly (engine power 48 h.p.), and exceeds them by 19 to 21%. The Russian-made vehicle Stels 800 Guopard (engine power 67 h.p.) exceeds Polaris Sportsman 1000 vehicle (engine power 85 h.p.) in maximum drawbar pull at snatch load by 4%. This can be explained by better hitch weight implementation in the Russian models.

Fragments of UTV comparative tests to determine maximum drawbar pull at snatch load are presented in Figure 2.

5. Conclusions

The RM 650-2 UTV's maximum drawbar pull stood at 6,190 N.
The Stels 800 Guopard UTV's maximum drawbar pull stood at 5,370 N.
The Yamaha Grizzly UTV's maximum drawbar pull stood at 3,460 N.
The BRP Outlander Max XT UTV's maximum drawbar pull stood at 3,831 N.
The BRP Outlander 6x6 UTV's maximum drawbar pull stood at 8,710 N.
The Polaris Sportsman 1000 UTV's maximum drawbar pull stood at 4,183 N.
The Russian-made UTV RM 650-2 (engine power 42.5 h.p.) develops higher drawbar pull than equal in power foreign-made vehicles BRP Outlander Max XT (engine power 48 h.p.) and Yamaha Grizzly (engine power 48 h.p.), and exceeds them by 32 to 45%. The Russian-made vehicle Stels 800 Guopard (engine power 67 h.p.) exceeds Polaris Sportsman 1000 vehicle (engine power 85 h.p.) in maximum drawbar pull by 22%. This can be explained by better hitch weight implementation in the Russian models.

The RM 650-2 UTV's maximum drawbar pull at snatch load stood at 17,490 N.
The Stels 800 Guopard UTV's maximum drawbar pull at snatch load stood at 16,090 N.
The Yamaha Grizzly UTV's maximum drawbar pull at snatch load stood at 13,777 N.
The BRP Outlander Max XT UTV's maximum drawbar pull at snatch load stood at 14,139 N.
The BRP Outlander 6x6 UTV's maximum drawbar pull at snatch load stood at 20,038 N.
The Polaris Sportsman 1000 UTV's maximum drawbar pull at snatch load stood at 15,416 N.
The Russian-made UTV RM 650-2 (engine power 42.5 h.p.) develops higher drawbar pull at snatch load than equal in power foreign-made vehicles BRP Outlander Max XT (engine power 48 h.p.) and Yamaha Grizzly (engine power 48 h.p.), and exceeds them by 19 to 21%. The Russian-made
vehicle Stels 800 Guepard (engine power 67 h.p.) exceeds Polaris Sportsman 1000 vehicle (engine power 85 h.p.) in maximum drawbar pull at snatch load by 4%. This can be explained by better hitch weight implementation in the Russian models.

Figure 2. Fragments of UTV tests to determine maximum drawbar pull at snatch load: a) RM 650-2; b) Stels 800 Guepard; c) Yamaha Grizzly; d) BRP Outlander 6x6

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