

Vehicle Cross-Country Capability

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Abstract:

In the article the author gives a complete description of the vehicle's cross-country ability, which is the ability of a vehicle to overcome various obstacles and difficult road sections, such as off-road, deep snow, sand, mud or rocky areas. This parameter is especially important for SUVs, special equipment, and vehicles used in extreme conditions. In addition, modern technologies such as traction control systems, anti-slip systems and stabilization systems also play an important role in increasing the vehicle's cross-country ability. High cross-country ability is necessary in conditions of lack of good road surface and is especially appreciated in rural areas, at construction sites and during extreme travel.

Keywords: Cross-country ability, system, angle, lock, drive, property, road, car, condition, soil.

Introduction. Cross-country ability is an operational property that determines the ability of a vehicle to perform transport and other functions in poor road conditions, when driving off-road and overcoming various obstacles. Poor road conditions include wet, dirty, snowy, icy, broken and soggy roads. On such roads, the movement and maneuvering of a vehicle is difficult, which affects average speeds and fuel consumption.

Main part. When driving off-road, the vehicle's propeller interacts with soil surfaces, which are divided into four types: 1) cohesive loamy soils (light loamy, loamy, heavy loamy) in solid, plastic and fluid states; 2) loose sandy soils (silty, fine-grained, medium-grained, coarse-grained) in uncompacted, slightly compacted and compacted states; 3) swampy soils in undrained and drained states; 4) snow in settling, settled and wind-compacted states. Obstacles include: slopes, barrier (continuous) and discrete obstacles, water obstacles. Obstacles are divided into natural and artificial. Slopes can be longitudinal (ascents and descents) and transverse (slopes). Barrier obstacles are considered to be road embankments, irrigation and drainage canals, roadside ditches, sidewalk curbs, ditches, trenches, canals, scarps, counterscarps, walls. The profile of barrier obstacles is formed by combinations of thresholds (benches) and short slopes. Barrier obstacles, as a rule, are artificial structures for national economic and military purposes.

Discrete natural obstacles include trees, stumps, boulders, hummocks, craters, holes, etc. Water obstacles are divided into fords and those that can be crossed by swimming. The ability of a vehicle to move according to its cross-country ability is determined by the ratio:

$$F_{т\phi} \geq F_{т0} \geq \Sigma F_{д}, (1)$$

where $F_{т\phi}$ – adhesion force of the drive wheels to the supporting surface; $F_{т0}$ – gross tractive force (traction force) on the drive wheels; $\Sigma F_{д}$ – the sum of the forces resisting the movement of the vehicle. The loss of cross-country ability may be complete or partial. In the case of a complete loss of cross-country ability, a vehicle gets stuck – the vehicle stops moving. A partial loss of cross-country ability is associated with a decrease in the speed of movement and an increase in fuel consumption under certain transportation conditions, which affect the productivity of the vehicle and the cost of transportation. Cross-country ability is assessed not only by its indicators, but also using indicators of other operational properties (traction speed, fuel efficiency, and in some cases controllability, stability, maneuverability, smoothness of movement, etc.).

Profile cross-country ability characterizes the ability of a car to overcome unevenness of the road, obstacles and fit into the required traffic lane. As evaluation indicators of profile cross-country ability are accepted: 1) ground clearance h_k ; 2) front and rear overhangs L_1 and L_2 ; 3) front and rear overhang angles γ_1 and γ_2 ; 4) longitudinal angle of passability λ_{np} ; 5) longitudinal radius of passability R_{np} ; 6) cross-country radius R_{non} ; 7) maximum angle of climb α_{max} ; 8) the greatest angle of the slope to be overcome β_{max} ; 9) road train flexibility angles α , β и γ ; 10) bridge tilt angle $\gamma_{п}$; 11) coefficient of coincidence of tracks of front and rear wheels η_c ; 12) width of a ditch to be crossed in the transverse direction b_p ; 13) height of vertical wall to be overcome (scarp) h_c ; 14) ford depth H_{δ} . The last three indicators are used to evaluate the cross-country ability of all-wheel drive vehicles. a b

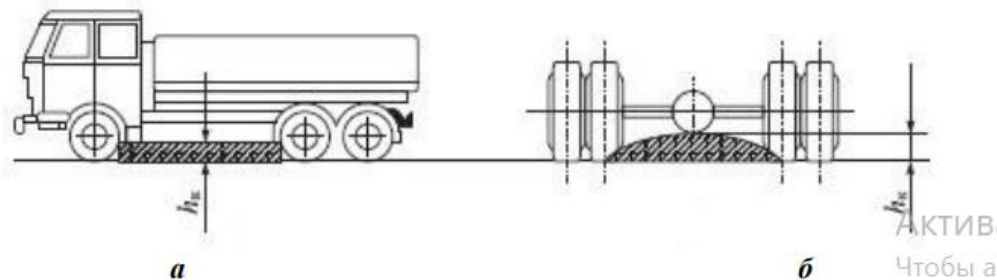


Fig. 1. Ground clearance:

a – between axles; b – under axle Ground clearance h_k .

A distinction is made between the ground clearance between the axles and the under axle clearance (Fig. 1). The ground clearance between the axles (Fig. 1, a) is the shortest distance between the road surface and the lowest fixed point of the vehicle. The ground clearance under the axle (Fig. 1, b) is the distance to the road surface from the highest point of the arc of a circle that passes through the middle of the tread pattern of the tires of one axle or the inner tires of dual wheels and touches the lowest point of the vehicle between the wheels. In this case, no rigid part of the vehicle should be in the shaded area of the figure. When determining the ground clearance, multi-section bridges are considered as one axle. If necessary, the ground clearance of multi-axle vehicles is indicated under all axles depending on their position from the front to the rear, for example, for a three-axle vehicle - 280 / 250 / 250. The ground clearance determines the ability to move on deformable support surfaces, in particular, on ruts rolled on soft soils, on snow, as well as the ability to overcome individual natural obstacles off-road (stones, stumps, hummocks, etc.). The ground clearance of trucks is standardized depending on the load capacity in order to ensure rational layout and stability.

The ground clearance of a trailer must be no less than that of a tractor, and for vehicles and road trains with increased and high cross-country ability, it must be significantly greater than that of vehicles with limited cross-country ability. Front L_1 and rear L_2 overhangs (Fig. 2). Overhang is the distance from the extreme point of the contour of the front (rear) protruding part along the length of the car to the plane perpendicular to the supporting surface and passing through the centers of its front (rear) wheels.

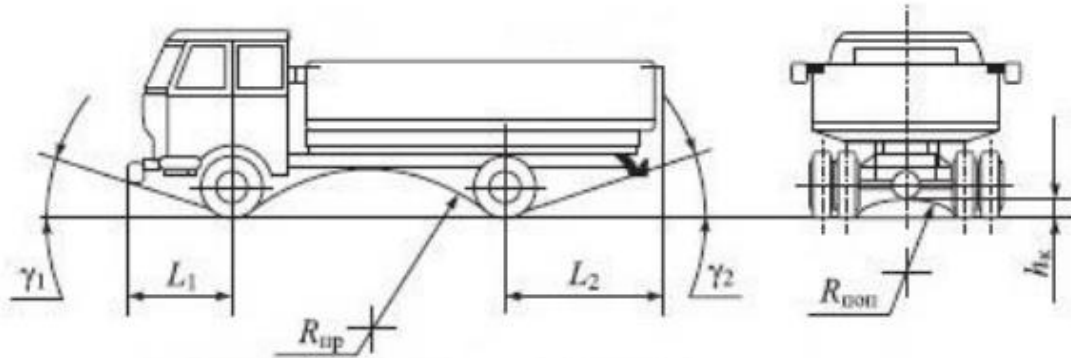


Fig. 2. Parameters of the vehicle's cross-country ability

The size of the overhangs affects the vehicle's cross-country ability when overcoming steep climbs and descents, ditches, thresholds, ditches and other obstacles. The smaller the overhangs, the lower the probability of losing contact of the wheels with the supporting surface when overcoming obstacles and, consequently, the higher the vehicle's cross-country ability. Angles of the front γ_1 and back γ_2 overhangs (Fig. 2). The front overhang angle is the maximum angle between the road surface and the planes tangential to the front tires under static load such that no point of the vehicle in front of the front axle is below these planes and no part of the vehicle, with the exception of the running boards, is located below the said planes. The rear overhang angle is the maximum angle between the road surface and the planes tangential to the rear tires under static load such that no point of the vehicle behind the rear axle is below these planes and no part of the vehicle is below the said planes.

The bending angles of a road train (Fig. 5) α and β form the corresponding limit positions of the longitudinal axes of the tractor and semi-trailer, the angle of flexibility γ – transverse tilt of the semitrailer relative to the tractor unit (if the fifth wheel coupling has a third degree of freedom).

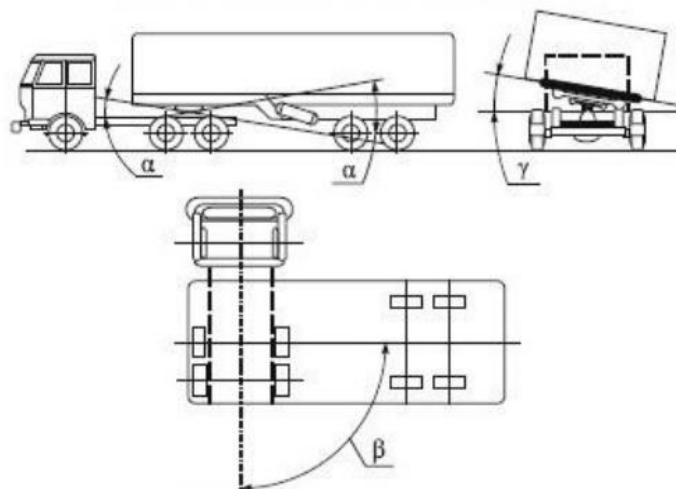


Fig. 5. Flexibility angles of a road train

Conclusion. Thus, the conducted analysis shows that the angles of longitudinal and transverse vertical flexibility of a road train characterize the ability to move on longitudinal and transverse slopes and on uneven roads, and the angle of horizontal flexibility characterizes the ability of a road train to fit into a given traffic lane.

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