The XXXI-st SIAR International Congress of Automotive and Transport Engineering
"Automotive and Integrated Transport Systems" (AITS 2021),
28th-30th October 2021, Chisinau, Republic of Moldova
Conference Series: Materials Science and Engineering, 2022, Vol. 1220, Nr. 1

Theoretical estimation of the drawbar pull for two-axle automotive vehicles

I. Preda

https://doi.org/10.1088/1757-899x/1220/1/012013

Abstract

The drawbar pull, defined as the amount of force available to an automotive vehicle at the drawbar for pulling or accelerating a load, represents an important characteristic used to define its traction performances. Because the experiments necessary to determine that force are relatively difficult and expensive to realize, a theoretical assessment of that characteristic may be extremely useful to identify the traction potential of the studied vehicle. This paper presents an algorithm able to approximate the realizable drawbar force of an automotive vehicle when it moves on different types of ground. For the computation, the ground characteristics may be adopted from the literature, while the necessary input data of the vehicle is normally given by the manufacturers or can be relatively easily obtained by measurements. The algorithm can be very useful in the primary stages of vehicle design. The paper also presents some influences of the constructive data and driving conditions on the drawbar force magnitude.

Keywords: drawbar pull, automotive vehicles, driving conditions, drawbar force magnitudes

References

1. Vehicle Dynamics Terminology (revised 2008-01-24), 1976 (Society of Automotive Engineer, Inc.)
Go to reference in articleGoogle Scholar
2. He R, Sandu C, Mousavi H, Shenvi M, Braun K, Kruger R and Els S 2020 Updated Standards of the International Society for Terrain-Vehicle Systems Journal of Terramechanics **91** 185-231
Go to reference in articleGoogle Scholar
3. Untaru M, Poţincu G, Stoicescu A, Pereş G and Tabacu I 1981 Dinamica autovehiculelor pe rop, (Bucharest: Editura Didacticá şi Pedagogics)
Go to reference in articleGoogle Scholar

4. Guiggiani M 2014 The Science of Vehicle Dynamics - Handling, Braking and Ride of Road and Race Cars, (London: Springer)
Go to reference in articleGoogle Scholar
5. Kutzbach H D, Bürger A. and Böttinger S. 2019 Rolling radii and moment arm of the wheel load for pneumatic tyres Journal of Terramechanics **82** 13-21
Go to reference in articleGoogle Scholar
6. Schreiber M and Kutzbach H 2007 Comparison of different zero-slip definitions and a proposal to standardize tire traction performance Journal of Terramechanics **44** 75-79
Go to reference in articleGoogle Scholar
7. Ydrefors L, Hjort M, Kharrazi S, Jerrelind J and Stensson Trigell A 2021 Rolling resistance and its relation to operating conditions: A literature review Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering **235** 2931-2948
Go to reference in articleGoogle Scholar
8. Priddy J 1995 Stochastic Vehicle Mobility Forecasts Using the NATO Reference Mobility Model. Report 3. Database Development for Statistical Analysis of the NRMM II Cross-Country Traction Empirical Relationships, (US Army Corps of Engineers)
Go to reference in articleGoogle Scholar
9. Milliken W F and Milliken D L 1997 Race car vehicle dynamics, (SAE)
Go to reference in articleGoogle Scholar
10. Gillespie T D 1992 Fundamentals of Vehicle Dynamics, (Warrendale, USA: SAE)
Go to reference in articleGoogle Scholar
11. Nastasoiu M and Ispas N 2017 Determining the theoretical drawbar performance characteristics of tractors, considering the variation of the wheels radii during tractor operation, in CAR2017 Conference (Pitesti) 89-96
Go to reference in articleGoogle Scholar
12. Creager C, Asnani V, Oravec H and Woodward A 2017 Drawbar Pull (DP) Procedures for Off-Road Vehicle Testing, (NASA)
Go to reference in articleGoogle Scholar
13. Vantsevich V, Barz D, Kubler J and Schumacher A 2005 Tire Longitudinal Elasticity and Effective Rolling Radii: Experimental Method and Data, SAE Technical Papers **Kistler** 04/11
Go to reference in articleGoogle Scholar
14. Mitschke M and Wallentowitz H 2014 Dynamik der Kraftfahrzeuge, 5 (Auflage, Berlin: Springer)
Go to reference in articleGoogle Scholar
15. Hamersma H A, Botha T R and Els S 2014 Kinetic vs. kinematic roll radius on rough roads 18th International Conference of the ISTVS (Seoul, Korea, September 22-25, 2014) 1-6
Go to reference in articleGoogle Scholar
16. Wei Y, Oertel C, Li X and Yu L 2017 A theoretical model for the tread slip and the effective rolling radius of the tyres in free rolling Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering **231** 1461-1470
Go to reference in articleGoogle Scholar
17. 2001 The tyre grip, Société de Technologie Michelin
Go to reference in articleGoogle Scholar
18. Preda I 2020 Ecuatia generala de miscare - nimic mai simplu! ? (The general equation of motion - nothing simpler!?), (Ingineria Automobilului) 9-15
Go to reference in articleGoogle Scholar
19. Niţescu G, Năstăsoiu S and Popescu S 1974 Tractoare, (Bucureşti: Editura Didactica si Pedagogica)
Go to reference in articleGoogle Scholar

20. Ciobotaru T 2009 Semi-Empiric Algorithm for Assessment of the Vehicle Mobility Leonardo Electronic Journal of Practices and Technologies 19-30 July-December 2009
Go to reference in articleGoogle Scholar
21. Roşea P 2019 Studiu privind transpunerea procedurilor de testare specifice vehiculelor militare în mediul virtual (Academia Tehnica Militara, Bucuresti) Ph.D Thesis
Go to reference in articleGoogle Scholar
22. Wasfy T M and Jayakumar P 2021 Next-generation NATO reference mobility model complex terramechanics - Part 2: Requirements and prototype Journal of Terramechanics **96** 59-79
Go to reference in articleGoogle Scholar
23. Preda I 2005 Aspects regarding the wheel loads of tractor-semitrailer road train, in CAR2005 Conference (Pitesti)
Go to reference in articleGoogle Scholar
24. 1994 AVTP 03-60 Drawbar Pull and Resistance to Motion on Hard Surface
Go to reference in articleGoogle Scholar
25. 2007 Test Operations Procedure (TOP) 2-2-604 Drawbar Pull.
Go to reference in articleGoogle Scholar
26. Jacobson B 2016 Vehicle Dynamics. (Compendium for course MMF062, Chalmers University of Technology)
Go to reference in articleGoogle Scholar
27. Wong J Y 2001 Theory of Ground Vehicles, Third (Ottawa: Wiley)
Go to reference in articleGoogle Scholar
28. Kobelski A, Osinenko P and Streif S 2020 A method of online traction parameter identification and mapping, IFAC-PapersOnLine **53** 13933-13938
Go to reference in articleGoogle Scholar
29. Naranjo S D, Sandu C, Taheri S and Taheri S 2014 Experimental testing of an off-road instrumented tire on soft soil Journal of Terramechanics **56** 119-137
Go to reference in articleGoogle Scholar
30. Preda I and Ciolan G 1997 Modelarea interactiunii dintre roata si sol, in CAR1997 Conference (Pitesti)
Go to reference in articleGoogle Scholar
31. [31]Pacejka H B 2006 Tyre and Vehicle Dynamics, Second
Go to reference in articleGoogle Scholar
32. Roşea R, Rakosi E and Manolache G 2004 Wheel Traction Prediction - A Comparison Between Models and Experimental Data
Go to reference in articleGoogle Scholar
33. Sandu C, Taheri S, Taheri S and Gorsich D 2019 Hybrid Soft Soil Tire Model (HSSTM). Part II: Tire-terrain interaction Journal of Terramechanics **86** 15-29
Go to reference in articleGoogle Scholar
34. Truţă M, Marinescu M and Vînturiş V 2016 Influence of the drawbar pull over the power flux within the automotive transmissions IOP Conference Series: Materials Science and Engineering **147** 012131
Go to reference in articleGoogle Scholar
35. Preda I, Pereş G, Untaru M and Ciolan G 1988 Quelques aspects de l'utilisation des modelés mathématiques a l'étude des sollicitations dans la transmission des voitures, (Brasov, Romania: CONAT1988 Conference) A229-237
Go to reference in articleGoogle Scholar
36. Gadola M, Chindamo D and Lenzo B 2021 Revisiting the Mechanical Limited-Slip Differential for High-Performance and Race Car Applications Engineering Letters **29** 824-839
Go to reference in articleGoogle Scholar

37. Năstăsoiu M and Ispas N 2019 Proceedings of the 4th International Congress of Automotive and Transport Engineering (AMMA 2018). Proceedings in Automotive Engineering (Cham: Springer) Potential Performance Characteristics for Different Types of Tractors: Two-Wheel-Drive Tractor, Four-Wheel-Drive Tractors and Crawler Tractors 521-526
Go to reference in articleGoogle Scholar