Annals of DAAAM for 2010 & Proceedings of the 21st International DAAAM Symposium, Volume 21, No. 1, ISSN 1726-9679
ISBN 978-3-901509-73-5, Editor B. Katalinic, Published by DAAAM International, Vienna, Austria, EU, 2010
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Annals of DAAAM International

ON DOUBLE WISHBONE FRONT SUSPENSION MECHANISMS

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Abstract: *The paper studies: a) the geometrical modeling using the Autodesk Inventor software of the double wishbone front suspension mechanisms having rigid joints; b) the influence of these mechanisms on the guiding of the front wheels that is determined by the variations of: the track half-width, the camber angle and the steering axis inclination.*
Key words: *Suspension; wishbone; mechanisms; modeling; kinematics.*

1. INTRODUCTION

The present paper approaches some aspects and the modeling and analysis of operation of double wishbone front suspension mechanisms. The automotive vehicle suspensions determine in a significant extent the vehicle performances of stability, handling and passenger comfort.

The double wishbone front suspension mechanisms are the most used in vehicle construction because of simple kinematics and a great number of possible solutions to cover different applications (Genta, G. & Morello, Vol. 1 and 2, 2009; Reimpell et al., 2001). The latest research in the area shows that the modeling and kinematics analysis of suspension mechanisms is approached in the majority of references in field (list of references is restraint in the limited space of the paper). The kinematics of the suspension mechanism having rigid and compliant joints was studied using multibody simulation software (Simionescu & Beale, 2002). The orientation of the wheel by adopting specific values of the camber angle and toe angle influence the forces at the contact patch of the wheel-road (Mariotti & Ficarra, 2008).

The paper aims are: a) the geometrical modeling using the Autodesk Inventor software of this type of double wishbone front suspension mechanisms having rigid joints; b) the influence of these mechanisms on the guiding of front wheels that is determined by the variations of: the track half-width, the camber angle and the steering axis inclination.

Future research will be oriented on the suspension mechanisms having compliant joints, but also on complex models that combine more possible solutions of double wishbone front suspension mechanisms.

2. CAD MODELS OF SUSPENSION MECHANISMS

Lukin et al. (1989) recommend the ratio of the superposed arms in the range 0.55…0.65 determining variations of: max. 4-5 mm for the track half-width; max. 5-6 degrees for the camber angle. The model of the suspension mechanism taking into accounts these recommendations is given in the fig. 1.

The mentioned ratio of arms is difficult to be respected because of the space restrictions (the case of passenger cars). To obtain a convenient wheel guiding, a grater ratio of superposed arms and a larger distance from pivots by upward displacement of the superior pivot are adopted as needed. This model is presented in the fig. 2 for a ratio of the superposed arms of 0.82. It is noted that in this solution (with upward movement of the superior arm), the steering axis inclination suffers modifications, with negative or positive effects, as appropriate.

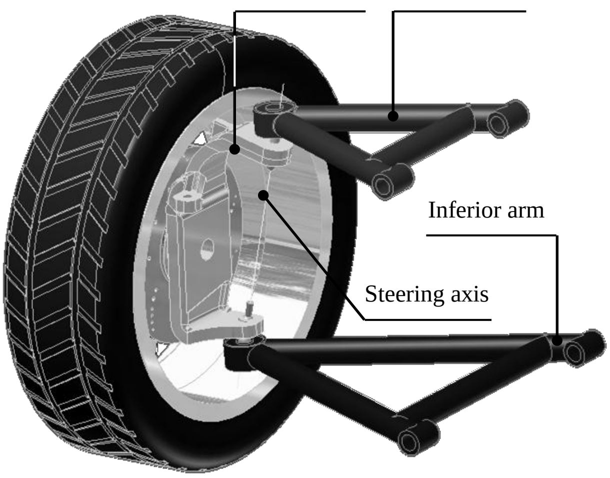

Fig. 1. The virtual model of the suspension mechanism with the ratio of the superposed arms of 0.55

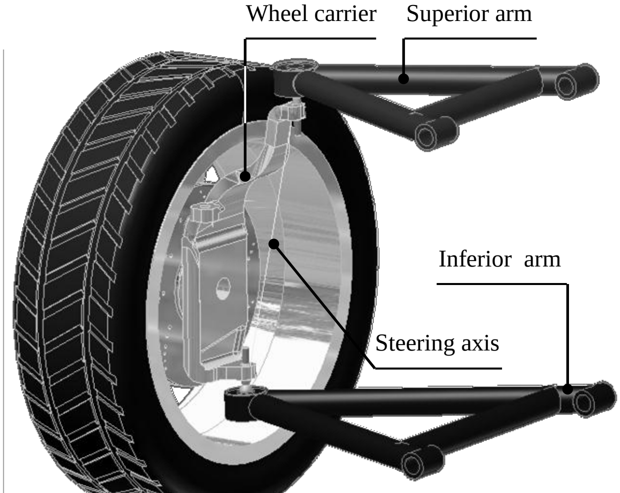

Fig. 2. The virtual model of the suspension mechanism with the ratio of the superposed arms of 0.82

Another solution consists of the upward displacement of the superior pivot accompanied by its lateral outward displacement, so that the superior pivot is placed above the wheel (fig. 3). Thus the following positive effects result: a) possible lower values of the angle of the steering axis; b) the close of the steering axis to the median plan of the wheel; c) the increasing of available transversal space between the front wheel passages.

But e negative of the solution is the increasing of the wheel passages.

3. BEHAVIOR OF THE GUIDING MECHANISMS

The behavior of the wheel guiding mechanisms modeled before could be described by the variations the track width, wheel camber angle and of the steering axis angle depending on the wheel vertical displacement. The diagrams of variation of the track half-width and camber angle are represented for the previous models in the fig. 4 and 5.

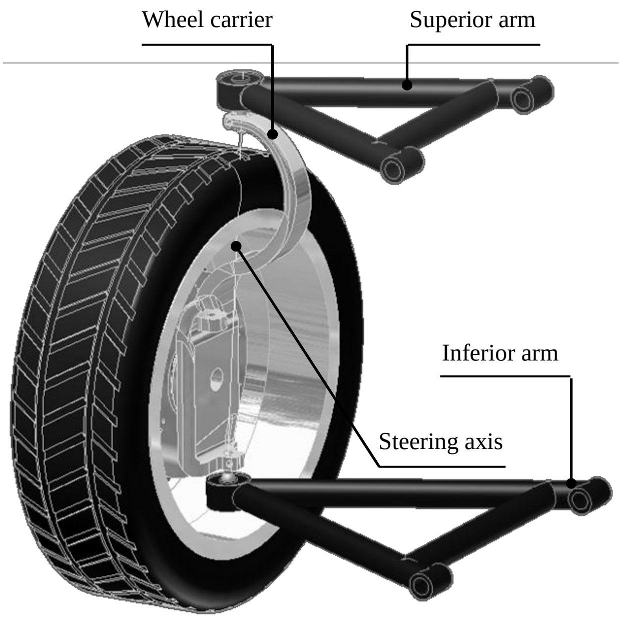

Fig. 3. The virtual model of the suspension mechanism with same ratio of the superposed arms of 0.82 and having superior pivot displaced upward and lateral outward

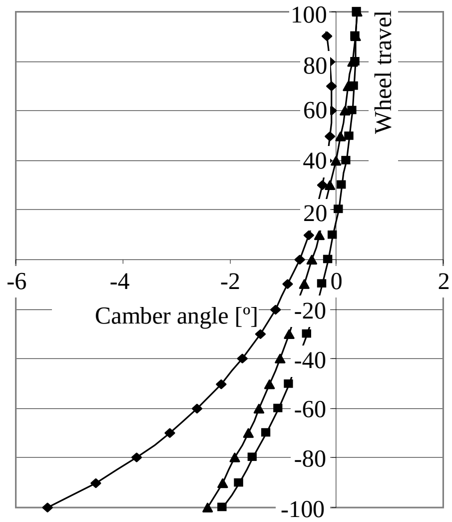

Fig. 4. The wheel camber angle depending on wheel travel (positive for spring compression) in the case of virtual models from fig. 1 (◆), fig. 2 (■) and fig. 3 (▲)

The fig. 4 shows that the variations of the wheel camber angle are greater for rebound wheel travel at the model from fig. 1 in comparison with the other models. The fig. 5 illustrates the variations of the track half-width: the model from the fig. 1 has a lowest variation at the rebound wheel travel. Thus, the study of different models could offer the optimum solution in terms of vehicle performances, as appropriate.

4. CONCLUSIONS

The following conclusions are pointed out below.

1. The virtual modeling of the studied double wishbone front suspension mechanisms having rigid joints could emphasize the effects of different solutions on the vehicle performances of stability, handling and passenger comfort.

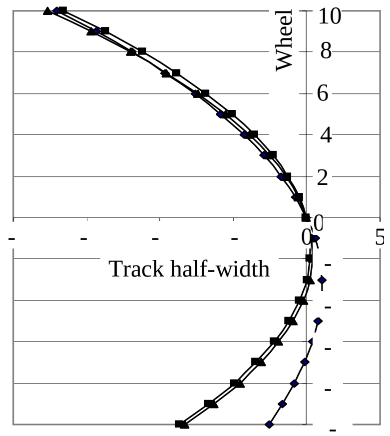

Fig. 5. The track half-width depending on wheel travel (positive for spring compression) in the case of virtual models from fig. 1 (◆), fig. 2 (■) and fig. 3 (▲)

2. The three developed models of the double wishbone front suspension mechanisms having rigid joints cover the area of the available constructive design directions to influence the guiding of wheels and implicitly the automotive vehicle stability and the comfort of passengers.

3. The effects on the guiding of wheels, automotive vehicle stability and the comfort of passengers of the models of suspension mechanisms are visible by analyzing three parameters (track width, wheel camber angle and steering axis inclination) depending on the wheel vertical displacement.

5. ACKNOWLEDGEMENTS

The work has been funded by the Sectoral Operational Programme Human Resources Development 2007-2013 of the Romanian Ministry of Labour, Family and Social Protection through the Financial Agreement POSDRU/88/1.5/S/60203.

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