THE ANALYSIS OF CAR MULTI-LINK REAR AXLE

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Rezumat. *Aceasta lucrare prezinta cateva solutii constructive ale puntilor fractionate spate ale autoturismelor utilizand softul Autodesk Inventor Professional 2008, in scopul determinarii variatiei unor parametrii care influenteaza din punct de vedere functional comportamentul autovehiculului. Sunt analizate trei tipuri de punti fractionate cu suspensie independenta multilink utilizate pe autovehicule din clasa medie. Rezultatele sunt concretizate prin reprezentarea modului in care ecartamentul si unghiul de cadere al rotii variaza in functie de deplasarea rotii prin comprimarea si relaxarea suspensiei. In timpul functionarii mecanismelor puntilor apar incompatibilitati cinematice.*

Abstract. *This paper presents several constructive solution of the car rear axle using the Autodesk Inventor Professional 2008 software, in order to determine the variation of some parametres which are influencing the functionality of the car behavior. Three car multi link rear axle are used on the midle car class. The results are interpreted through the way that the semi-track width and the camber angle are varied depending on the wheel displacement by the compression or relaxation of the wheel suspension. During the use of the rear axle results the kinematics incompatibilities. In order to solve this incompatibilities.*

Keywords: Rear axle. Car. Kinematic incompatibilities. Track width. Wheel camber angle.

1. Introduction

Knowledge of the state of the art in the automotive industry is encumbered by the need for confidentiality and secrecy in relation to the results of industrial research by auto makers. Usually, research in this field is conducted by researchers from the companies' product department, academic institutes or scientists with wide experience in the industry.

2. Analyzed models

This paper presents research starting from the analysis of an existing variant of multi-link rear axles (Fiat, Volkswagen and Honda cars).

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The first variant of suspension analyzed in this paper comes from a fractionated rear-axle and the lower triangular arm was replaced with three arms mounted, two on transversal direction and one direction longitudinal.[1,2] It is obtained a very good wheel steerage during suspension compression and relaxation. It is necessary that the longitudinal arms are parallel to the suspension, so in the suspension evolution a variation of the angle of convergence it will not appear, due to change in the wheel base and on the variation longitudinal damper.

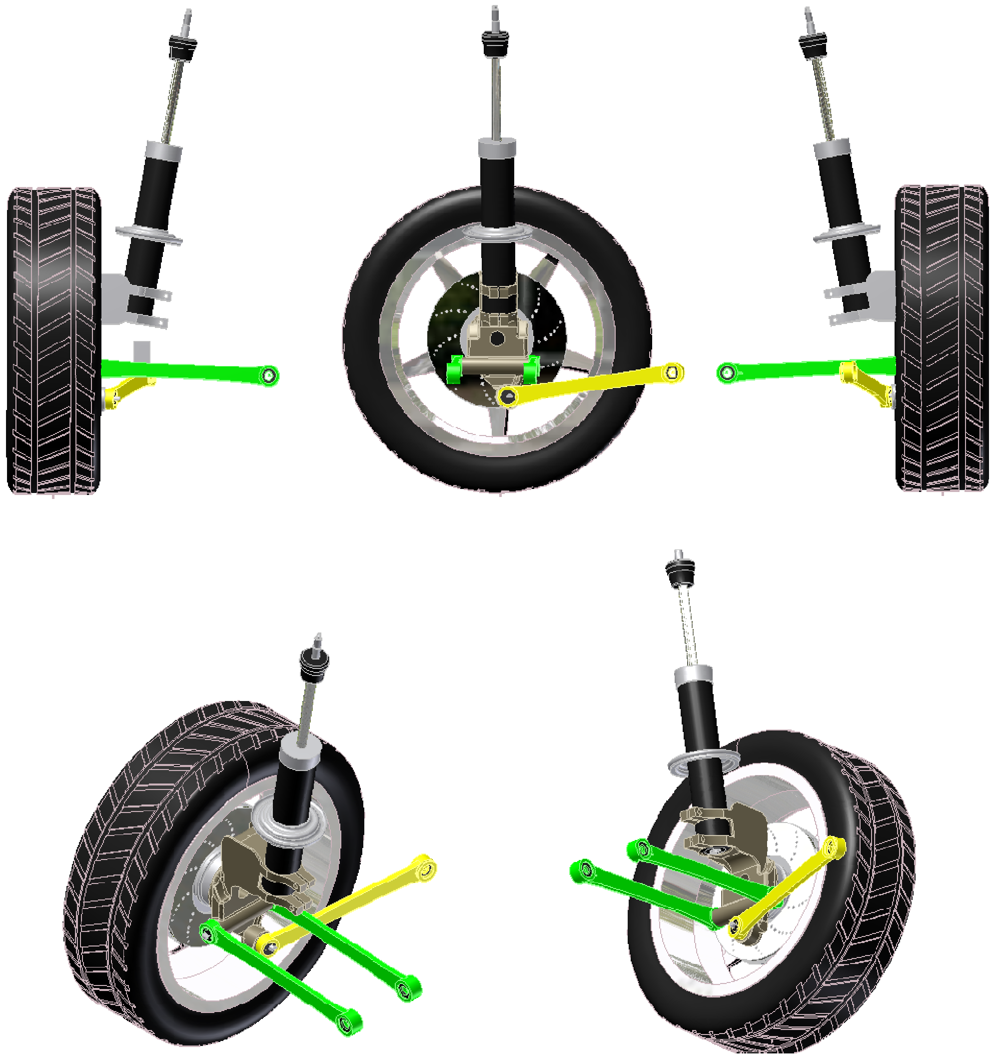

Fig.1 .Model of the Fiat rear axle

The second version is found on the Ford Focus. The longitudinal arm is attached to the chassis at one end and at the other end is fixed on the wheel carrier.[1,3] The transversal arms are articulated on the longitudinal arm, and support beams. The longitudinal arm has a lamellar construction, it can take heavy loads, on vertical and longitudinal direction, but at the same time it is able to easily deform at the interaction on transversal direction, behaved as an elastic laminae, resolving the debate appeared in the kinematic incompatibility suspension. In the progress of this rear-axle it is a cinematic incompatibility, since the mechanism is spatial and the plan of the longitudinal arm is determined by four points. Resolving this incompatibility can be achieved by using elastic joints, with preferential deformation on the axis that combine the centers of the arm joints.

To obtain different rigidities on privileged directions it is use cylindrical joint holes. The volume of rubber between the armature is greater, and it is done within the hole (hollow shapes and positions strictly determined). Constructive scheme is shown in the figure below.

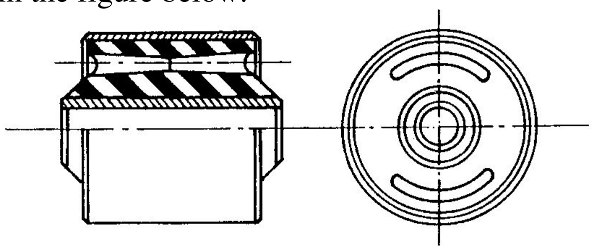

Fig 2. The cylindrical joint wafers constructive scheme

There are two cross beams joined by two short longitudinal beams forming a rigid assembly, which takes the chassis. Because the port bow arm strains are high, it has been choose the use of rigid joints attachment to both support beam and on the longitudinal arm assembly. Resolving the incompatibility by using deformable joints can be done by emploing elastic bushes in the first two transversal arms.

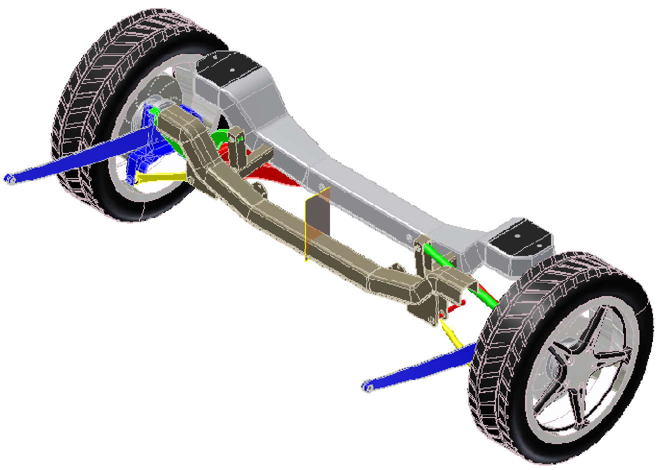

Fig.3 .Model of the Ford rear axle

Since the rear-axle is symmetrical, improved kinematics and setting angles of fall and the convergence of the wheel to the left arms were approximated with straight bars, in this case the lenths are able to change easily. After positioning the joint centers, cross arms were modeled as shape. Another multi-link axle configuration studied in this paper has the starting point the rear axle used by Honda Civic. Similarly, also in this configuration are incompatible kinematics. Since the longitudinal arm has a rigid configuration, the possibilities of solving this problem is represented by the elastic joint.

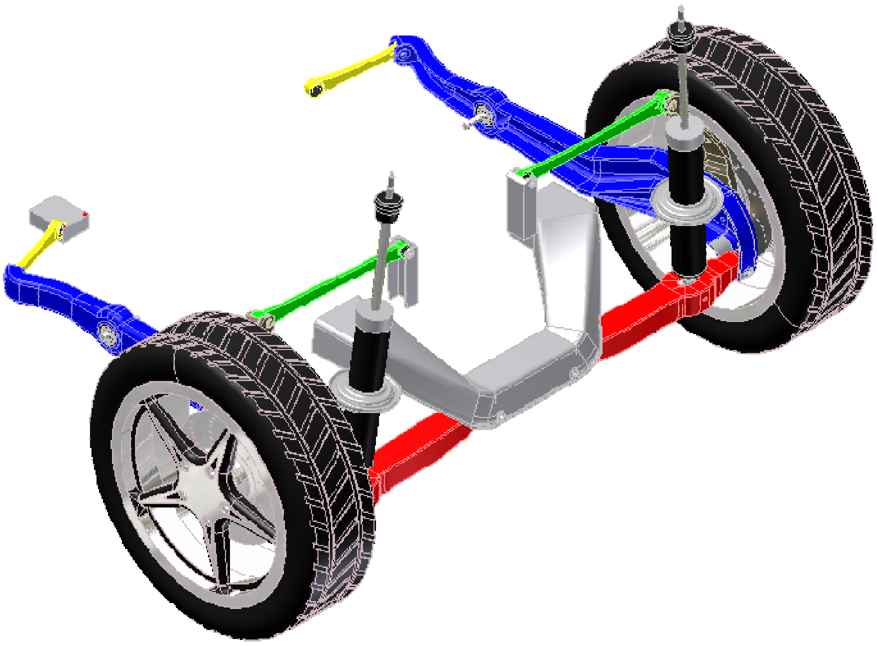

Fig. 4. Model of the Honda rear axle

The variation of track width caused by the studied mechanisms along the compression and relaxation of the suspension spring defines the trajectory of the tyre contact patch. The results are contextualized in diagrams showing that the modifications of the analyzed parameters are very important, with a negative influence on car stability and the comfort of passengers. The interpretation of these diagrams allows the choice of favorable constructive solutions to increase car performance.

3. Work methodology

The multi-link axle system used on the Ford Focus was modeled using the graphics modeling program Autodesk Inventor Professional 2008.[4] It is passed, then, to the study of effects of given structure on track width and wheel camber angle. For this, the position of the center contact patch between wheel and the track was firstly defined and the position of this point was determined in a fixed reference system (composed trough a transverse plane and a longitudinal (Fig.5); this allowed to emphasize the variation semi-track width and the trajectory of the center contact patch, when the wheel moves in an upright direction (wheel travel), at the compression and relaxation of suspension spring.

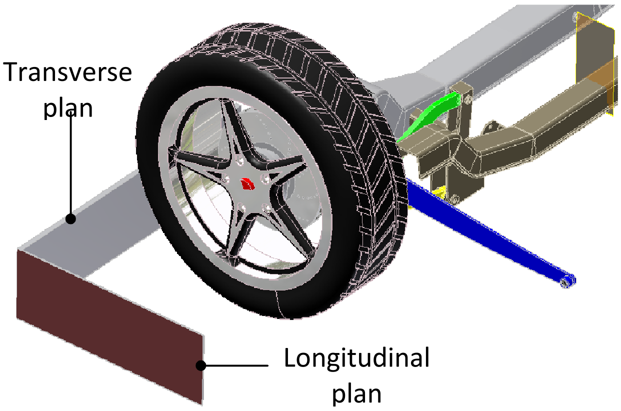

Fig. 5. Reference plans for measuring semi-track width and wheel camber angle

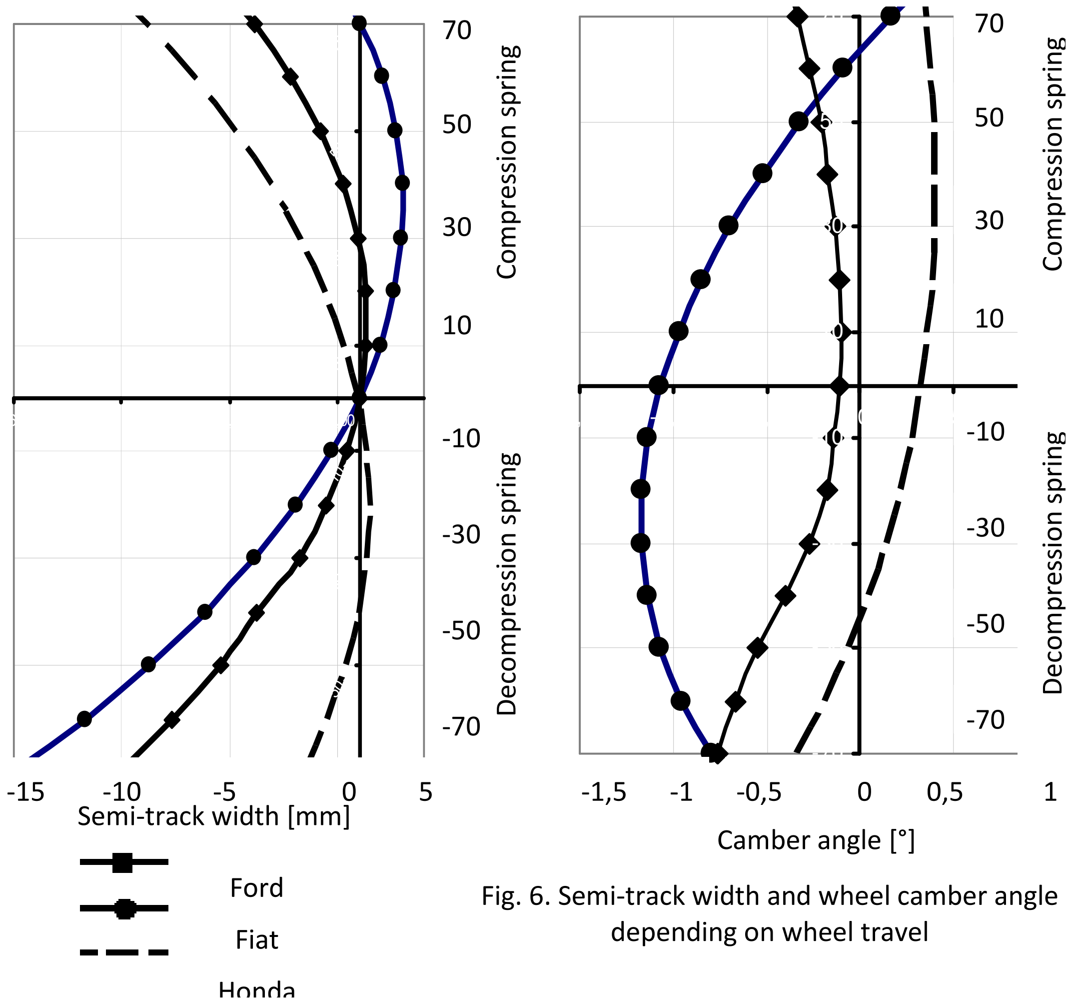

Fig. 6. Semi-track width and wheel camber angle depending on wheel travel

The highlighting of the wheel camber angle is made by determining the angle between the longitudinal plane of the reference system and the median wheel plan (moving vertically). [5]

Conclusions

1. The kinematic incompatibilities of the multi-link guiding mechanisms cause impossibility of operation under certain circumstances dictated by the shape, size and strength of components.
2. Using graphical modeling and animation through specialized software it is possible to: a) emphasize, firstly, the kinematic incompatibilities that occur after mechanism modeling; b) solve these incompatibilities by constructive changes, c) emphasize the effects of the mechanism on two parameters (track width and wheel camber angle) that influence the guiding of car wheels and implicitly car stability and passenger comfort.

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REFERENCES

[1] A. Zomotor: Fahrwerktechnik: Fahrverhalten, 2 Aufl. (Vogel Buchverlag, Würzburg, 1991);

[2] J. Reimpell, J. W. Betzler: Fahrwerktechnik: Grundlagen. (Vogel Buchverlag, 2005);

[3] J. Reimpell, H. Stoll, J. W. Betzler: The Automotice Chasis: Engineering Principles (Butterworth/Heinemann, 2001);

[4] V. Mateescu, L. Georgescu, M. Tica: International Congress "Automotive, Safety and Environment"- SMAT 2008, Craiova 2008, tome 1, pp. 106-114;

[5] P. Alexandru, I. Visa, D. Talaba, C. Alexandru, C. Antonya: Modelarea statico-dinamica a mecanismelor de ghidare ale rotilor automobilelor (Editura Lux Libris, Brasov, 2005).