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Denis Chemezov
Vladimir Industrial College
M.Sc.Eng., Corresponding Member of International Academy of Theoretical and Applied Sciences, Lecturer, Russian Federation
https://orcid.org/0000-0002-2747-552X
vic-science@yandex.ru

Aleksey Matankin
Vladimir Industrial College
Student, Russian Federation

Vadim Maksimov
Vladimir Industrial College
Student, Russian Federation

Elena Zaytseva
Vladimir Industrial College
Lecturer, Russian Federation

Irina Pavlukhina
Vladimir Industrial College
Lecturer, Russian Federation

Georgiy Karatun
Vladimir Industrial College
Student, Russian Federation

Dmitriy Satarin
Vladimir Industrial College
Student, Russian Federation

THE STATIC ANALYSIS OF BEVEL GEARS ENGAGEMENT

Abstract: *The modeling results of bevel gears engagement obtained in the "SolidWorks" computer program are presented in the article. The analysis of contact pressure on the faces of engaged teeth and displacement (deformation) of the parts material of the bevel gear pair of external engagement was performed.*

Key words: *the bevel gear, contact pressure, displacement, engagement.*

Language: *English*

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Introduction

The bevel gear pair is the gear pair consisting of two gears, the axes of which intersect. The bevel gears are made with the straight, helical and spiral teeth [1-9].

Engagement of the bevel gears, for transmitting power by rotation at the angle, occurs on the variable

area of the teeth faces. This process is accompanied by the occurrence of contact stresses and bending stresses in the gears material under the action of the circumferential force in the engagement zone. The distribution and the value of stresses in the material volumes of the wheel teeth are calculated using the computer simulation of static or dynamic problems. Depending on the operating mode of the bevel gear pair and material from which the driving and driven members are made, the life of the mechanism parts is predicted. The calculation of the bevel gear pair with the gear ratio of 1 in the conditions of the average normal loading mode is given in the scientific work.

Materials and methods

The analysis of stress and strain state of material of the bevel gears at the point of engagement was performed after computer modeling in the "SolidWorks" software environment [10]. The three-dimensional solid models of the bevel gears had the following geometry: the teeth number of the driving and driven members – 25; the external circumferential module – 5 mm; the axes angle – 90°0′00′′; the profile angle – 20°0′00′′; the addendum ratio – 1; the radial clearance ratio – 0.25; the ratio of the curvature radius of the transition curve at the boundary point of the tooth profile – 0.38; the face width – 25 mm; the addendum modification coefficient of the driving wheel – 0.386; the coefficient of change in the calculated tooth thickness of the basic rack profile of the driving wheel – 0; the outer diameter – 134.8 mm (for the driving wheel) and 129.342 mm (for the driven wheel); the value of intentional offset of the measuring section – 0 mm; the accepted distance from the outer end face to the measuring section – 12.5 mm. The solid models of the bevel gears in engagement are presented in the Fig. 1.

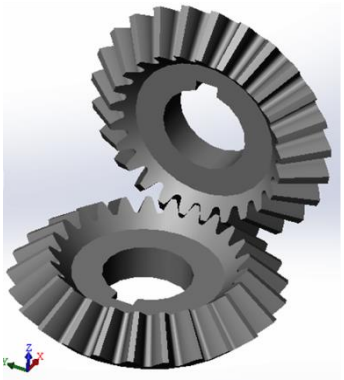
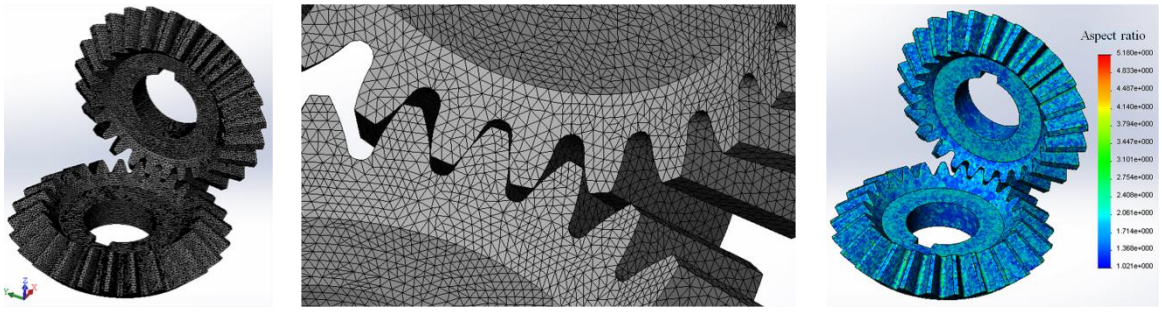


Figure 1 – The solid models of the bevel gears in engagement.

The properties of alloy steel were set for the wheel models. The friction coefficient at the contact of the teeth of the bevel wheels was accepted 0.1. The torque of 200 N×m was applied to the driving wheel model. The resulting reaction force of 1069.65 N and its components along three coordinate axes were determined: 20.6994 N (the *X*-axis), -1069.35 N (the *Y*-axis), and -14.377 N (the *Z*-axis). The models were divided into finite elements (the mesh based on the curvature). Dividing the bevel gears models into the finite elements and the analysis of the mesh quality are presented in the Fig. 2.



A ***B*** ***C***

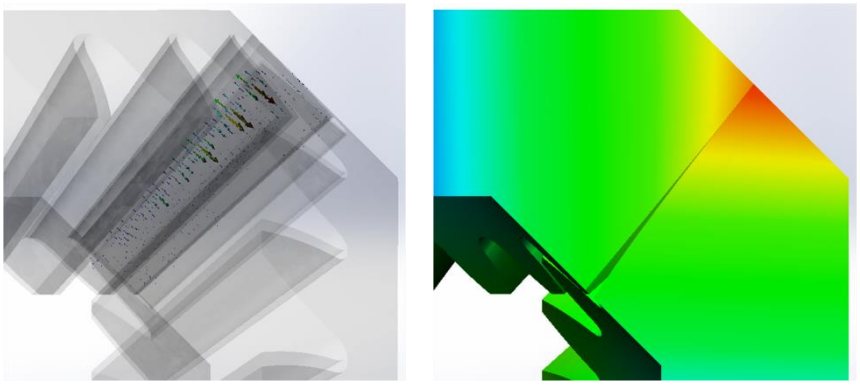
Figure 2 – The solid models of the bevel gears after dividing into the finite elements: *A* – the general view; *B* – magnification of the engagement point of the wheels; *C* – the aspect ratio plot of each models element.

The dimensions of the finite elements varied from 0.911752 mm to 1.51959 mm, which provided getting the high-quality mesh and, accordingly, high accuracy of the results. The aspect ratio plot describes the shape of the tetrahedral elements. The aspect ratio of the ideal tetrahedral element is 1.0. 98% of the elements have the aspect ratio close to 1.0. Small edges, curved shapes, and sharp corners on the models

have the aspect ratio of more than 4.0. The results accuracy will decrease in these elements.

Results and discussion

The results of the static calculation of engagement of the bevel gears are presented in the form of color vectors and contours that characterize the degree of stress and strain state of the parts material of the gear pair. The red color of the vector or the contour describes the maximum value of the parameter. The calculated contours of contact pressure on the teeth faces and displacement (deformation) of material of the bevel gears are presented in the Fig. 3.



A ***B***

Figure 3 – The contours of contact pressure (*A*) and displacement (*B*) in the section of the engagement point of the bevel gears.

The section of the parts at the engagement point was performed for the more detailed analysis of stress and strain state of material of the driving and driven gears. The contact pressure vectors show the direction and the value of the stress action of the tooth material during the contact of the faces. It is noted that the stress value varies along the contact line of the teeth. From the side of the maximum contact length on the tooth face, the stress value will be 2.5 times more than from the side of the minimum contact length.

The displacement contours of material show the most loaded volume of the bevel wheels teeth, highlighted in red. This contributes to destruction of the wheel tooth addendum in the first place. The remaining volume of the teeth is deformed almost uniformly.

Conclusion

Contact pressure during engagement reaches the maximum value from the side of the maximum area of the face of the wheel tooth. Based on calculated deformation (displacement) of the wheels material, it is possible to make the forecast about the probable destruction volume of the tooth element. Chipping the tooth addendum from the side of the maximum engagement length of the gears is possible.

References:

1. (1973). *GOST 19325-73. Bevel gear pairs. Terms, definitions and symbols.*
2. (1981). *GOST 13754-81. Basic requirements for interchangeability. Gearings conical with straight gears.*
3. (1956). *GOST 1758-56. Basic norms of interchangeability. Bevel and hypoid gears. Tolerances.*
4. (1966). *GOST 12289-66. Bevel gears. Basic parameters.*
5. (1974). *GOST 19624-74. Straight bevel gear pairs. Calculation of geometry.*
6. (1973). *GOST 19326-73. Spiral bevel gear pairs. Calculation of geometry.*
7. (1968). *GOST 13754-68. Gears are toothed. Initial contour of bevel gears with straight and tangential teeth.*
8. (1970). *GOST 16202-70. Gears are toothed. The initial contour of the bevel gears with circular teeth.*
9. (2014). *ISO 10300-1: 2014(E). Calculation of load capacity of bevel gears. Pt. 1: Introduction and general influence factors*. Second ed. Geneva, 58 p.
10. (2021). Welcome to SOLIDWORKS Online Help. https://help.solidworks.com/2021/English/SolidWorks/sldworks/r_welcome_sw_online_help.htm