THE FUNCTION PROPERTIES OF THE CONIC WHEELS IN THE TRACTOR CENTRAL TRANSMISSIONS

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In the article the indexes of function property of central transmission tractor and methodics their determination is considered.

One of the most important groups in the structure of the tractor mechanic stepped transmission is the central transmission realizing by the complete pair of circular-toothed conic wheels.

Crossing axis of the both driving and driven shafts of the crawler tractor or of the driving shaft and the body of the wheel differential gear playing the past of the driven shafts in the wheel tractor on which the driver gear and the crown of the driven wheel are fastened allow to transmit the increasing revolving moment in the gear ratio times u_{CG} from the engine with a long axis to the cross – cut axis of the driving stars of the caterpillar engine or to the axis of the wheel-tractor driving wheels.

The capacity for the work of the circular teeth of the conic wheels and the rolling shaft bearings depends on many reasons such as: the complicated structure and design, not always rational meanings of the initial geometric parameters and the derivative ones as well of the tooth cravens of central transmission wheels, the complicated and labourconcuming technology of assemblage and control making, the complicated operation conditions on the different soils of the various climatic zones, the maintenance in corresponding with the high standard and sometimes the insufficient profession able training of an operator. The probability index of the reliable work recommended for such transmissions $P(t) = 0,8$ [1] and technical resource L_h taken in the branch $[L_h] = 6000$ [2] are reduced.

Situation analysis, including the classification, diagnosis and examination of the unfaultless causes in the capacity for the work and the mathematical model of quality consisting of the three-leveled criteria and dozens indices allow synthesizing an integral index of quality u_Q [3]. The meanings of it are “low” $u_Q < 0,5$, “normal” $0,5 \le u_Q \le 0,75$ or “high” $u_Q > 0,75$ ensure the corresponding general function properties of the central transmission (CT).

Hence the following characteristics are:

1. The specific revolving moment on the drive gear shaft as an assumed ratio, potentially realizing proceeding from the geometric parameters of the transmission and assuming strains of the tooth wheel materials on the contact endurance or the bend one, the revolving moment T_{1P} to the relative physical volume of the transmission V_{CG}, i.e.

$$K_{TV} = T_{1P} / V_{CG} . \quad (1)$$

As the physical volume CT the total volume of two truncated cones of the drive gear and the driving wheel is taken and can be defined by the following dependence [4]:

$$V_{CG} = 0,125 \pi d_{e_2} K_{be} \left(1 - K_{be} + 0,33 K_{be}^2\right)\left(1 + u_{CG}\right) / u_{CG}^2 , \quad (2)$$

where $d_{e_{2(1)}}$ - the external divided diameter of the driver (driving) wheel; $K_{be} = b / R_e$ - the coefficient of the tooth crown width b with the external conic distance R_e.

The assuming revolving moment on the drive gear shaft is taken from the condition:

$$T_{1P} = \min \left\{ T_{1HP}; T_{1FP} \right\}. \quad (3)$$

The meanings of the potential realizing revolving moments are followed from the article dependences ensuring:

- the contact endurance of the active surfaces case – harden circular teeth

$$T_{1HP} \le d_{e_2}^3 K_{be} \left(1 - K_{be}\right) u_{CG} \, \sigma_{HP}^2 / \left(K_d^3 K_H\right); \quad (4)$$

- the endurance of the circular teeth bend of “weaker” transmission wheels

$$T_{1FP} \le m_{te}^3 K_{be} \left(1 - K_{be}\right) z_1^2 \left(1 + u_{CG}^2\right)^{0,5} \left(\sigma_{FP} / Y_{FS}\right) / \left(K_m^3 K_F\right). \quad (5)$$

In the formula (5) the radio σ_{FP}/Y_{FS} is taken in minimum from two ratios defining the endurance of the drive gear teeth and driven wheel

$$\sigma_{FP}/Y_{FS} = \min\left\{\sigma_{FP_1}\left(0,5\pi + x_{\tau_1}\right)/\left(0,5\pi Y_{FS_1}\right); \sigma_{FP_2}\left(0,5\pi + x_{\tau_1}\right)/\left(0,5\pi Y_{FS_2}\right)\right\}, \qquad (6)$$

where x_{τ_1} - the change coefficient of the calculated thickness of the drive gear tooth.

The own loads of the mistakes in the assemblage and the classic deformations and the revolving wheels are taken into account by the load coefficients, $K_{H(F)}$ which are recommended to define by the methods of Glison's firm [5].

The coefficient of the diameter K_d, having the scale $H^{0,33}/mm^{0,67}$ and non – scaled coefficient of the modulus K_m are from the article [4]:

$$\begin{aligned} K_d &= 957\left(Z'_\varepsilon \cos\beta_n\right)^{0,67}; \\ K_m &= 15,7\left(1/K_{eff} \cos^2\beta_n \cos\alpha_n\right)^{0,33}. \end{aligned} \qquad (7)$$

The meaning of the basis coefficient Z'_ε, taking into account the total length of the contact lines and the quantity of the assuming strains are calculated according to the methods taken from article (6) or are taken from the diagram picture 1 article 4.

The basis coefficients $Y_{FS_{1(2)}}$, taking into account the shape of the tooth and endurance concentration, the coefficient K_{eff}, taking into account an effective width of the tooth crown and corresponding σ_{FP}/Y_{FS} according to the formula (6) are defined by the methods are described in article 7 or from diagrams picture 2 and 3 and article [4].

The assuming bend $\sigma_{FP_{1(2)}}$ strains on the transitional surface of the circular tooth uncalling metal fatigue material destruction with calculating probability of faultless work $P(t) \geq 0,99$ are taken according to standard GOST 21354-87 "The Tooth Cylindrical Transmission. The Strain Calculation", because the marks of steel for the manufacture of the central transmission (CT) conic wheels are the same as for the cylindrical wheels. These steels strengthen the mechanical treatment ways. Bat the conditions exploitation of the conic transmission are adequate to the cylindric ones.

Mark the meaning T_{1P}, defining to formula (3) with due regard for dependences (4)…(7) must be satisfied the condition

$$T_{1P} \geq \max\{T_{1H}; T_{1F}\},\qquad (8)$$

2. Potentially realizing external load coefficient K_A as a ratio of the permissible limit short revolving moment T_{1P} on the same shaft according to the static strength of the gear (wheel).

As the permissible revolving moments by a criteria of the contact strength are proportional to the square of the corresponding permissible contact stresses and they are proportional to the first degree of the permissible stresses by the bending strength criteria so rotationally realizing coefficient of the external load cfn be defined from the following condition:

$$K_A = \min\left\{\left(\frac{\sigma_{HP\max_1}}{\sigma_{HP}}\right)^2; \left(\frac{\sigma_{HP\max_2}}{\sigma_{HP}}\right)^2; \frac{\sigma_{FP\max_1}}{\sigma_{FP_1}}; \frac{\sigma_{FP\max_2}}{\sigma_{FP_2}}\right\}.\qquad (9)$$

To calculate the meaning K_A by the dependence (9) the fulfillment of the condition (8) is necessary and enough. Otherwise, the meaning K_A is calculated by the formula:

$$K_A = \min\left\{\left(\frac{\sigma_{HP\max_1}}{\sigma_{H}}\right)^2; \left(\frac{\sigma_{HP\max_2}}{\sigma_{H}}\right)^2; \frac{\sigma_{FP\max_1}}{\sigma_{F_1}}; \frac{\sigma_{FP\max_2}}{\sigma_{F_2}}\right\},\qquad (10)$$

where σ_H is the calculated contact stress in the pitch point and $\sigma_{F_{1(2)}}$ are the calculated local stresses from the bend in the unsafe section on the transitional teeth surface of the drive gear (index «1») and the driven wheel crown (index «2») defining of the assumed load action $T_{1H(F)}$ [8] by the dependences in the articles [6] and [7] in accordance.

The permissible limit stresses $\sigma_{HP\max_{1(2)}}$ are defined by the chemical – thermal treatment of the teeth. The permissible stress $\sigma_{FP\,M_{1(2)}}$ depends on the limit stress $\sigma^{\circ}{}_{FSt_{1(2)}}$ not called the tooth break and safety factor coefficient $S_{FSt_{1(2)}}$ defined by the probability of the reliable work of the transmission $P(t)$ [1], the durability coefficients $Y_{NM_{1(2)}}$, taking in account the load condition [8] according to the equivalent cycles and also the coefficients taking in account the grinding of the transitional surface, $Y_{dSt_{1(2)}}$, deformational strength; $Y_{RSt_{1(2)}}$ roughness of the transitional surface.

We mark that the meanings of the lilim stresses and the coefficients are followed from the GOST 21354-87 standard.

3. The mechanical efficiency accounting the loss of power in the tooth pitch, in the rolling friction bearing and aerohydroloss in the aerial and oily medium when revolving of tooth transmission wheels is defined by ratio:

$$\eta_{CG} = 1 - (\varphi_E + \varphi_P + \varphi_A). \tag{11}$$

In view of the fact that the sum of the loss coefficients is stable as a rule and it has the limitation $\varphi_P + \varphi_A \le 0{,}01...0{,}02$, the too thing loss have the main meaning. A certain relation for the biequivalent cylindrical transmission can define the loss coefficient:

$$\varphi_E = 2{,}3f\left(\frac{\cos\delta_1}{z_1} + \frac{\cos\delta_2}{z_2}\right)\cos^3\beta_n, \tag{12}$$

where f is a coefficient of friction.

According to the elastohydrodynamical theory [9] the coefficient f depends on the slipping speed V_S, the volume viscosity μ_0, and the ellipticity coefficient $K = a/b$ (a and b are the meanings of the big and little axie shafts of the momentary contact band [10]), the angle $\vartheta_к$ between the speed direction of slip V_S and the big axie shaft of the momentary ellipse contact [10], minimum meaning of the active circular tooth rough bur faces $R_{Z\min}$. The roughness of the active circular tooth surfaces is recommended to set a relation of the pitch ratio p_n and its limit deviation f_{pt} [11].

4. The temperature index $T°_{CG}$ is equal to the sum of volume temperature $T°_M$ of the set termal rate and the maximum momentary temperature rise in the zone of the tooth contact $\vartheta°_{max}$ [9] estimating by W. Coleman's formula based on H. Blok's theory:

$$T°_{CG} = T°_M + \vartheta°_{max}. \tag{13}$$

5. The probability of the reliable operation CT $P(t)_{min}$ is defined by the article [1].

6. The technical resource $L_{h\,min}$ is defined by the "weakest" link of the transmission that consists of the teeth or the rolling friction bearings. The meaning of it is followed from the work relations [1] and [2].

To a great degree the diving characteristics of function property of central transmission are the result of the CT quantity which is assured by the strict regulated technology of the large – serial production first of all [11].

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