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# PERFECTION OF CONSTRUCTION AND METHODS OF CALCULATION FOR UNIVERSAL SPINDLES OF ROLLING MILLS

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There are examined variants of the constructive solutions directed at the decrease of contact pressure on the working surfaces of the insert of the universal spindle coupling for rolling figere. The rated relations connected with the practical application of these solutions are given.

Keywords: spindle, universal coupling, insert, contact pressure, decrease

Tenure of employment for spindles of rolling mill in a great depends on reliability of their universal spindles, that determined by distribution of pressures on their working surfaces. Applied inserts have a form of continuous cylindrical segment with flat and cylindrical working surfaces [1]. The analysis of deformation for such insert specifies on the underexploitation of working part, considerable unevenness of distribution of pressures on it, and, consequently, to presence of areas, where pressure is considerably exceeded legitimate values.

The tasks of work there are development of constractional elements of insert, assisting the increase of the use area of his working parts by even distribution of pressures with the simultaneous decrease of its maximal values; estimation of calculation dependences, related with the practical use of these decisions.

A task was examined at next assumption: insert compresses between absolutely hard elements by the clevic of hinge and blade of roller. Then according to the Hooke's law, it is possible to write down :

$$P_{XZ} = \frac{E \cdot \delta_{XZ}}{h_{XZ}} , \qquad (1)$$

where $P_{XZ}$ is pressure on the working surface of insert in a point with the coordinates $X$, $Z$; $E$ is the module of resiliency for material of insert; $\delta_{XZ}$ is deformation of compression for fibres of insert; $h_{XZ}$ is a height of coercible fibres.

Dependence (1) over can be brought to the kind.

$$P_{XZ} = \frac{E \cdot \Delta \cdot a \cdot (x - \tilde{n})}{2c \cdot \left[ m \cdot a - z \cdot (m - n) \right]} , \qquad (2)$$

where $m$, $n$, $a$ are sizes of section for insert; $2c$ is an extent of the undeformed area of insert.

Dependence (2) and epures of pressures, built on it basis, show the unevenness of their distribution. Presence of areas high-pressure on the surface of new insert (angular areas) negatively tells on it earning burn-in. Therefore advisable is implementation on the flat working surface of insert of slants [2] with a slope to the butt ends of insert (on length) and with a slope from a middle to the lateral verges (on a width). The size of slants can be characterized by the ordinate $Y_{ba}$ in the angular point of flat working surface, which is determined from equality of relative deformations for coercible fibres in the butt-end plane of insert in points with co-ordinates B, A and B, C.

Then get

$$Y_{\hat{a}\grave{a}} = \frac{\Delta(m-n)\cdot(b-c)}{2m\cdot c-\Delta\cdot(b-c)} \ . \qquad (3)$$

Size $c$, included in calculation dependence (3), determine, expressing the torsional moment with use pressures taking into account their distribution.

Presence of slants on a flat working surface and subsequent wear the size of which arrives (0.015…0.10) D [3], accompanied by smoothing of pressures on the width of insert. In this case $P_{XZ} = P_{XO} = \text{const}$, and, consequently, deformation of insert area by long $dx$:

$$\delta_{XZ} = \frac{2a\cdot P_{XZ}\, dx}{C_X} \ , \qquad (4)$$

where $C_X$ is a coefficient of inflexibility of elementary area of inserta.

From where

$$P_{XZ} = \frac{0{,}5\delta_{XZ}\cdot K}{a} \ , \qquad (5)$$

where $K = C_X/dx$ is specific inflexibility of insert (coefficient of inflexibility for insert of single length).

Thus:

$$K = 2E\int_0^a \frac{dz}{h_{XZ}} = \frac{2E\cdot a\cdot \ln\left(\dfrac{m}{n}\right)}{m-n} \ . \qquad (6)$$

Sizes of hinges are in certain correlations with their radius:

$$r = K_r\cdot R_h;\ n = K_n\cdot R_h;\ m = K_m\cdot R_h;\ a = K_a\cdot R_h;\ b = K_b\cdot R_h;\ S = K_S\cdot R_h \ . \qquad (7)$$

At known $K_S$, $K_r$ and $K_a - K_m = K_r - K_S$; $K_n = \sqrt{K_r^2 - K_a^2} - K_S$ formula for determination $K$ it is possible to present as

$$K = \frac{2E\cdot K_a}{\left(K_r - \sqrt{K_r^2 - K_a^2}\right)}\cdot \ln\frac{(K_r - K_S)}{\left(\sqrt{K_r^2 - K_a^2} - K_S\right)} = K_0\cdot E \ . \qquad (8)$$

For standard hinges: $K_r$ = 0,45…0,46; $K_a$ = 0,30…0,31; $K_s$ = 0,25…0,26 and $K_0$ ~ 5, where $K_0$ is the generalized coefficient of specific inflexibility of insert.

For the estimation of exactness for dependence (6) and (8) measured deformation of elements for insert long a 50 mm at the compression of them between two flags the pin surfaces of which corresponded to the working surfaces of roller and blade. Deformation was carried out on a hydraulic press by effort 4.0 MN and measured by three indicators. For the investigated elements at a calculation size $K$ =

$4.25 \cdot 10^5$ MPa a mean experimental value was 3.55(105 МПа, that allows to use dependences (6) and (8) for the high-quality estimation of power parameters of hinges.

Decrease of specific inflexibility for inserts can be attained both at making of them from materials with the small module of resiliency and at the change of construction for insert. A considerable effect is arrived at implementation of insert with internal cavities [4]. Quality of hollow inserts consists yet and in that these cavities can be used in the systems of greasing for hinge. The simple filling of such cavities and connection their openings lubricating material with working surfaces can considerably reduce the wear of inserts.

*Conclusion.* An analysis of two constructional decisions, providing the decrease of pressures on the working surfaces of insert: implementation of slants on a flat working surface with a slope to the butt ends of insert (on length) and with a slope from a middle to the lateral verges (on a width); making of insert with longitudinal cavities is executed. Calculation dependences, related to the practical use of these decisions, are offered.

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