RESEARCH IN DISMOUNTABLE SLIDE FRICTION PIVOT OPERATION FOR CONVEYOR CHAIN

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Abstract. The research in disassembled conveyor chain plates slide friction pivots movement is described in the article. Four different chain pivot cases are explored when the chain comes into gearing with a star and goes out of gear. The chain pivot axis position changes, the operating forces in the chain and different wear reasons of the chain axis neck are described.

Keywords: conveyor chain, slide friction pivots, chain axle.

Introduction

The chain contains identical plates, extruded in cold way, which join little axles. It is observed that for the conveyor chain with slide friction pivots and axles, which are free in rotation (for example, the chain according to ГОСТ 589-71 a.o.) [1], the necks of axles wear out over the whole circumference. It means that within the course of work the axles turn, and thereby they wear out rather equally, what increases the resistance to wear of the chain. Sometimes the axles do not turn, and thereby they wear out only from one side. Such pivots fall out faster. The resistance to wear for the conveyor chain with rotating axles was 1.8...2.0 times bigger than for a chain with fixed (non-rotating) axles [2].

The aim of the research – to establish specific features for component operation of slide friction pivots for dismountable conveyor chains. Such researches have not been found in special literature. We will search the answer to the question: 'Why do the chain axles rotate during the course of operation?' In Figure 1a entering of the chain section 1 in gearing with the asterisk is shown. Because the section 2 already is in gearing with the asterisk and rotates along with it and the axle 4, then slide and friction of the operating surfaces takes place in the pivot 4. We will consider the section 1, which enters in gearing as the section, which drives the axle in rotation in relation to the section 2.

Materials and methods

The following cases are possible:

1. The axle 4 does not turn towards the asterisk tooth 3. In this case the possible rotation of the axle 4 is impeded by the friction force F_{f2} between the rear end of the section 2 and axle 4, as well as by the friction force between the asterisk tooth 3 and axle 4 – F_{f3} (Fig. 1, b). In such a case the active friction moment T_{Ff1} from the friction force F_{f1} is smaller than the sum of the friction forces F_{f2} and F_{f3} and the friction moments T_{Ff2} and T_{Ff3}:

$$T_{F_{f1}} < T_{F_{f2}} + T_{F_{f3}}, \tag{1}$$

or

$$fF_1 \frac{d_1}{2} < fF_2 \frac{d_1}{2} + fF_N \frac{d_2}{2}, \tag{2}$$

where f – friction factor;
F_1 – tension force for driving section 1;
F_2 – tension force for section 2;
F_N – normal reaction from asterisk tooth 3 to axle 4;
d_1 and d_2 – diameter of axle friction surfaces.

If the axle 4 does not turn towards the tooth 3, when the section 2 turns along with the asterisk and the immovable axle 4 by the angle γ in the result of operation of the friction force F_{f1}, the operating front end surfaces of the plates 1 and axle neck within bow AB wear out. In Figure 1b with arrows is shown the deformation direction for the upper layers of the contact surfaces for the axle 4 and plates 1 and 2.

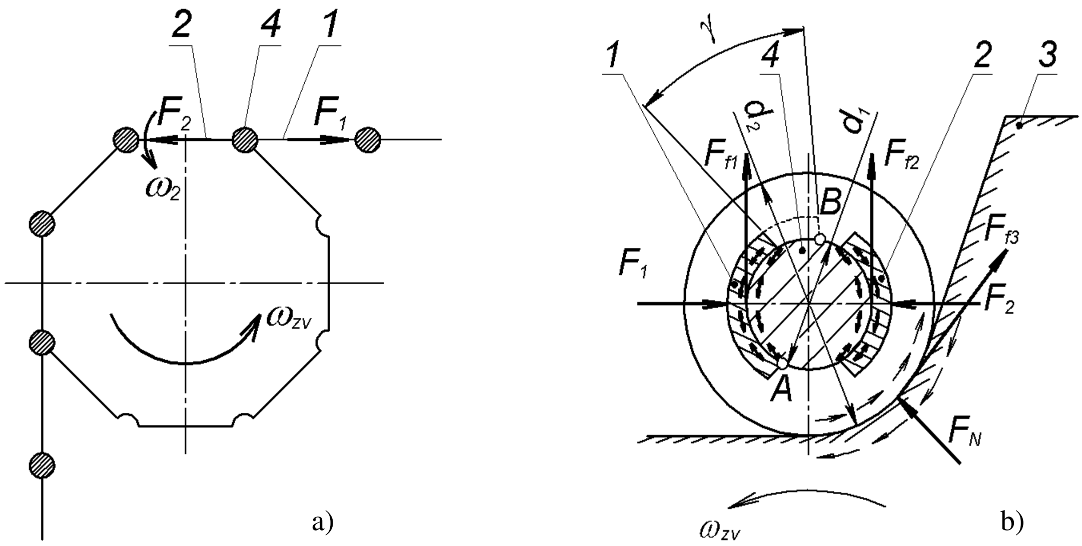

Fig. 1. **Scheme of pivot operation for chain section, which enters in gearing with asterisk:**
a – entering of chain section 1 in gearing with asterisk; b – forces applied to chain axle (axle does not turn); 1 and 2 – sections of chain and their operating elements; 3 – tooth of asterisk; 4 – chain axle

2. The axle turns towards the asterisk tooth (Fig. 2). In this case:

$$T_{F_{f1}} > T_{F_{f2}} + T_{F_{f3}}, \tag{3}$$

or

$$fF_1 \frac{d_1}{2} > fF_2 \frac{d_1}{2} + fF_N \frac{d_2}{2}, \tag{4}$$

and the driving section 1 turns along with the axle 4 in relation to the section 2 and the asterisk tooth 3. The deformation direction of the contact surfaces of the pivot components stays the previous one, but the other surfaces wear out – the axle neck within borders of the bow CD, the middle part of the axle within the contact area with the asterisk, asterisk tooth, as well as the operating surface of the rear end of the plate 2.

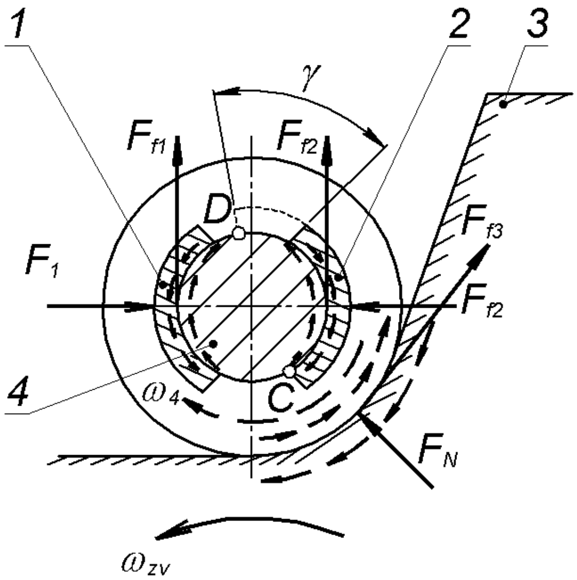

Fig. 2. **Operation scheme of chain pivot when axle turns within plate 2:**
1 and 2 – operating elements of chain section plates; 3 – asterisk tooth; 4 – chain axle

Supposing that the friction factor in all contact surfaces of the pivot is equal, then from (4):

$$F_1 > F_2 + F_N \frac{d_2}{d_1}. \tag{5}$$

As it is known [3], when the chain section enters into gearing with the asterisk, the force F_2 decreases, but the force F_N increases, in comparison with the constant force F_1. F_N of normal reaction always is smaller than the force F_1. It can be expected that the chain axle will turn over the section, entering in gearing with the asterisk. The axle can stop turning, for example, when wear and tear of its necks is not even (uneven hardness of axle material, a.o. factors).

When the section 2 exits gearing (Fig. 3), the section 2 becomes the driving section.

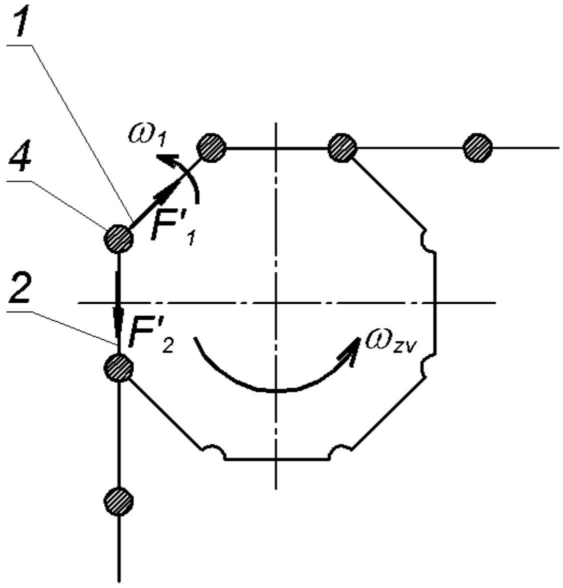

Fig. 3. **Operating scheme of pivot when chain section exits gearing with asterisk:**
1 and 2 – chain sections; 3 – asterisk tooth; 4 – chain axle

Also here two variants are possible:

1. The axle does not turn towards the asterisk tooth. In such a case:

$$T_{F'_{f2}} < T_{F'_{f1}} + T_{F'_{f3}}, \tag{6}$$

or

$$fF_2 \frac{d_1}{2} < fF_1 \frac{d_1}{2} + fF_N \frac{d_2}{2}, \tag{7}$$

and the operating surface of the rear ends of the plates 2 slide along the neck of the axle 4. There occurs wear and tear of these contact surfaces. Within chain pivots there occurs reversible friction.

2. The axle turns. Observing (6):

$$T_{F'_{f2}} > T_{F'_{f1}} + T_{F'_{f3}}, \tag{8}$$

and reversible deformation direction of the contact surfaces remains the same. The operating surface of the front end of the plate 1, axle neck, middle part and asterisk tooth wear out.

When the chain section 2 exits gearing with the asterisk, the friction forces F'_{f1}, F'_{f2} and F'_{f3}, which operate in the pivot 4, are smaller comparing with the time, when they enter gearing [3].

The axle neck along circumference under the internal and external operating surfaces of the plates wears evenly because the driving plates alter depending on which section enters or exits gearing.

The sector of surface sliding and wear and tear of the operation surfaces of the chain pivot depend on the friction moment proportion. Thereby, also a combined case of pivot operation is possible, i.e., within the borders of turning summary angle γ the axle can do both - rotate and stay immovable.

Results and discussion

The observations showed that chain pivots on conveyor turning asterisks do not stay on the operation surfaces of the teeth, and in the result of the chain load they slide down to the teeth foot, when the asterisk turns. It is known [4] that in reversible friction the wear and tear is approximately two times bigger than by single-acting non-reversible friction. In addition, the reversible friction decreases resistance of material corrosion [5].

To allow analyzing of the turning area of the axle, regularities of changes for the forces F_2 and F_N should be established.

Conclusions

1. The internal or external plates of the driving chain turn the axle in rotation movement only to one side – opposite to the rotation movement of the asterisk. The driving plates turn along with the axle. In such a way, the chain axles periodically turn and the wear and tear zone of the axle alters over the perimeter.
2. The plates, which turn the axle, are the plates which enter or exit gearing with the asterisk.
3. Within the chain pivot between the tooth and axle, only the reversible friction occurs.
4. Entering into gearing, the axle turns along with the driving plates opposite to the turning direction of the asterisk.

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