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STUDY OF RIB BENDING AT INSTALLATION OF INSERTION INTO RIB

ИССЛЕДОВАНИЕ ИЗГИБА КОЛОСНИКА В ПРОЦЕССЕ УСТАНОВКИ ВСТАВКИ В КОЛОСНИК

D.M. MUKHAMMADIEV, KH.A. AKHMEDOV, I.O. ERGASHEV, L.YU.ZHAMOLOVA, T.D. MUKHAMMADIEV

Д.М. МУХАММАДИЕВ, Х.А. АХМЕДОВ, И.О. ЭРГАШЕВ, Л.Ю. ЖАМОЛОВА, Т.Д. МУХАММАДИЕВ

(Institute of Mechanics and Seismic Stability of Structures named after M.T. Urazbaev of the Academy of Sciences of the Republic of Uzbekistan)

(Институт механики и сейсмостойкости сооружений им. М.Т. Уразбаева Академии наук Республики Узбекистан)

E-mail: davlat_mm@mail.ru

The existing rib designs are made taking into account their one-time use, which leads to an increase in financial and resource costs and a low accuracy in the assembly and in the strength of the grate. In addition, the practice of using grates in cotton ginning plants has shown that ribs in grate grills are worn out from the touch of the saws due to their warping and errors in the assembly of the grate. The wear of the grate in the working area leads to an increase in the inter grate clearance in the contact area with the saw blade and to a failure of the ginning process. To eliminate the above disadvantages, a new steel grate structure with an insert (a replaceable element) as a curved sheet is proposed; its ends are made in the form of a trapezoid. The grates have a ledge for a rigid and secure attachment to the bar. On the surface of the bar, there are holes for connecting the bar with the grate, made in the form of a quadrangle. However, in the scientific literature on the topic, there is no information on the study of the bending of the grate during the installation of the insert into the grate. Calculation schemes and experimental setups are proposed to establish the value of the grate deflection during the installation of the insert into the grate (cantilever installation and the installation on two supports). The values of the permanent deformation on the grate after installing the insert are: when the form is a rectangle – 0.016 mm, a triangle – 0.05 mm, and when the insert has a circular form – 0.08 mm. Therefore, the rectangular shape of the ends of the insert is a rational one. Using the recommendations for installing the insert in the grate will significantly reduce production costs and increase the level of accuracy during assembly, as well as the strength of the grate.

Существующая конструкция колосников изготавливается с учетом их одноразового использования, что приводит к увеличению финансовых, ресурсных затрат и низкому уровню точности при сборке и прочности колосниковой решетки. Кроме того, практика использования колосниковых решеток на хлопкоочистительных заводах показала, что колосники в колосниковых решетках изнашиваются от касания пил вследствие их коробления и погрешности сборки колосниковой решетки. Износ колосников в рабочей зоне приводит к увеличению межколосникового зазора в зоне контакта с

пильным диском и нарушению процесса джинирования. Для устранения вышеуказанных недостатков предложена новая стальная конструкция колосника со вставкой (сменный элемент) как изогнутый лист, концы которого выполнены в виде трапеции. Для жесткого и надежного крепления на брусе колосники имеется выступ. На поверхности бруса отверстия для соединения бруса с колосником выполнены в виде четырехугольника. Однако в научной литературе отсутствуют сведения об исследованиях изгиба колосника в процессе установки вставки в колосник. Предложены расчетные схемы и экспериментальные установки для определения значения прогиба колосника в процессе установки (консольно и на двух опорах) вставки в колосник. Значения остаточной деформации на колоснике после установки вставки составляют: в форме прямоугольника – 0,016 мм, треугольника – 0,05 мм и в круглой форме – 0,08 мм. Поэтому рациональной формой краев вставки является прямоугольная. Использование рекомендаций по установке вставки в колосник позволит существенно сократить производственные затраты и будет способствовать повышенному уровню точности при сборке и прочности колосниковой решетки.

Keywords: saw gin, rib, insert, design, insertion fixing force, insertion friction force, bending moment of the rib, tilt angle, insert displacement.

Ключевые слова: пильный джин, колосник, вставка, конструкция, сила закрепления вставки, сила трения вставки, изгибающий момент колосника, угол наклона, перемещения вставки.

The existing rib designs are made taking into account their one-time use, which leads to an increase in financial and resource costs and a low accuracy in the assembly and in the strength of the grate. In addition, the practice of using ribs in cotton ginning plants has shown that ribs in grate grills are worn out from the touch of the saws due to their warping and errors in the assembly of the grate. The wear of the rib in the working area leads to an increase in the inter rib clearance in the contact area with the saw blade and to a failure of the ginning process.

The disadvantage of the existing rib design is the manufacture of grates for their one-time use, which leads to an increase in financial costs and a low level of accuracy during assembly and the strength of the grate due to the fastening of the rib claws on the flat surface of the bar; this, in turn, affects productivity and quality indices of fiber and seeds during the operation of ribs.

To solve the above problems, R.G. Makhkamov, M. Agzamov, A.S. Ibragimov, A.A. Ismailov in their studies [1], [2] have conducted the choice of the basic parameters of the surface hardening of the working zone of the gin and linter ribs made of steel 45. The hardening temperature at the surface is 960°C and at the boundary of the heated layer 850°C [1]. The comparative tests of ribs with a hardened working zone using the selected hardening parameters showed that their service life is two times longer [2].

Tyutin P.N. and Melamedov R.Yu. [3], proposed a method for processing the side surfaces and claws of gin ribs using the method of single bases. Tests of ribs made according to the new technology have shown that the use of these ribs contributes to a significant reduction in the upper working face in the grates.

In patent [4], it was proposed to manufacture ribs from a polymer; the design excludes the formation of rust and the influence of moisture. If the fiber burns, only the rib will fail, not the saw blade.

In [5], a new design of the rib was proposed, which makes it possible when the rib is worn out to change the insert and not the whole rib.

The study in [6] investigated the attachment of the rib to the bar and the connections in the insert-screw–rib system. As a result, the minimum diameter and height of the screw crumple section of the insert–screw–rib system connection were established. The proposed design of the cantilever rib is characterized by the reaction force of the supports 3.5 times greater than that of the two-support rib.

The laws of change in the fastening force of the insert, the friction force, the efficiency of the joint, the angle of inclination and the relative strain of the rib, the allowance of the insert during manufacture were proposed in [7].

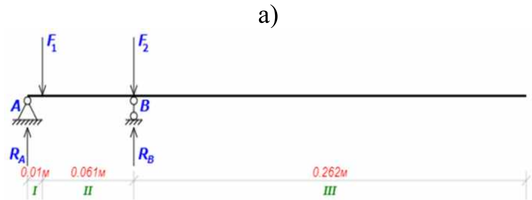
However, in the process of installing on the rib, the insert bends. In order to reduce the bending (deflection) of the rib, it is necessary to determine a rational scheme for the process of installing the insert on the rib, at which the minimum bending occurs. In order to determine a rational scheme for the process of installing the insert on the rib, the following types of ribs were considered:

- the rib is attached on one side - a console type (Fig. 1-a);

- the rib is fixed on both sides - a two-support scheme (Fig. 1-b).

The rib consists of a rectangle with the cross section h = 1.46b, loaded by forces F_1=200H and F_2= 200H, concentrated in the horizontal plane (Figs. 1a and 1b); the minimum dimensions of the right angle are b = 0.012 m and h = 0.0175 m, the normal stress for the rib is [σ] = 110 MPa [8], [9].

a)



b)

Fig. 1

As a result of calculations of the schemes for installing the insert on the rib, diagrams of transverse forces (Fig. 2), bending moment, bending angle and the bending were constructed (Fig. 3).

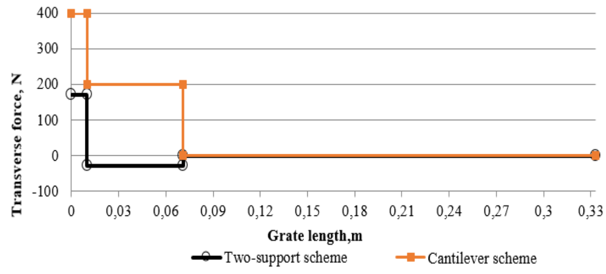


Fig. 2

To determine the rational scheme of the process of installing the insert on the rib, we calculate the bending of the rib for the cantilever and two-support schemes. In this case, the rib is divided into 3 sections (Fig. 1 – Scheme for calculating the installation of the insert on the rib: a – cantilever scheme, b – two-support schemes).

Analysis of the results of theoretical calculations (Figs. 2-3) of the process of installing the insert on the rib (of cantilever and two-support types) showed that the transverse force is 2.33 times less (from 400 to 171.83 N), the bending moment is 10.42 times less (from -16.2 to 1.7183 Nm), the angle of inclination is 23.93 times less (from 0.0344° to 0.0015°) and the bending of the rib is 27.2 times less (from 0.018 to 0.007 mm) with the two-support scheme as compared with the cantilever scheme.

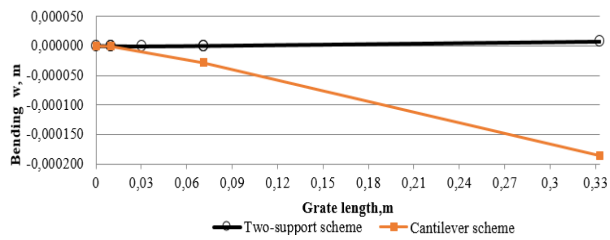


Fig. 3

Experimental study of the bending of the rib during the installation of the insert. According to Fig. 3, the bending of the rib is - 0.18 mm when the cantilever is installed, and it is - 0.007 mm on two supports. However, due to the fact that we can use micrometers with an accuracy of 0.01 mm [10], we will use a cantilever installation scheme for the experimental study of the bending of the rib. Therefore, to determine the experimental value of the bending of the rib, that is, the magnitude of deformation, a setup with four micrometers was built (Fig. 4 – scheme of the experimental setup to measure the bending of the rib when installing the insert: 1 – clamping force; 2 – insert; 3 – load measuring device; 4 – vernier caliper; 5 – rib cantiliver; 6 – ICh-10 0.01 dial gauges).

The design of the insert is of rib importance when it is installed on the rib. Therefore, to study the effect of the insert end on the bending of the rib, the insert of the following forms were made: rectangular (Fig. 5-a), triangular (Fig. 5-b) and circular (Fig. 5-c) shapes.

Fig. 4


a) rectangle b) triangle c) circular form

Fig. 5

The results of an experimental study, that is, the bending of the rib depending on the shape of the insert with a rectangular, triangular and circular section, are shown in Figs. 6…8 .

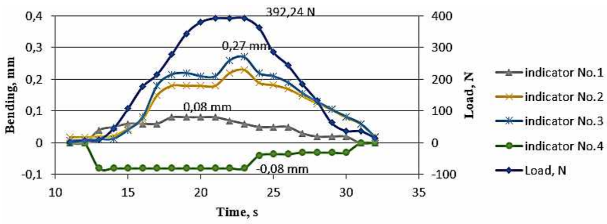


Fig. 6

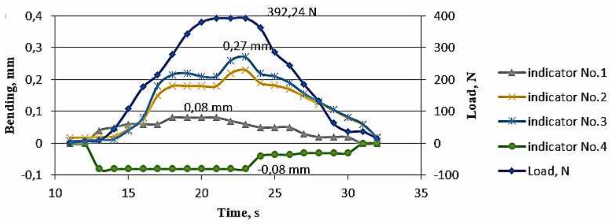


Fig. 7

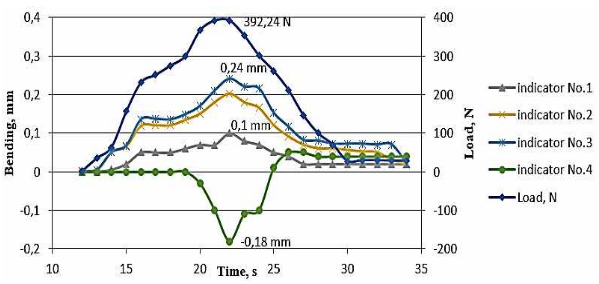


Fig. 8

Analysis of the results of the process of cantilever installation of the insert on the rib, obtained on the experimental setup (Fig. 4), showed that the bending of the cantilever of rectangular form under transverse force of 392.24 N is 0.27 mm, of triangular form - 0.25 mm, and of circular form - 0.24 mm. However, the value of the bending of the rib in the perpendicular direction is 0.08 mm for a rectangle, 0.25 mm for a triangle, and 0.18 mm for a circle (Figs. 6…8).

In addition, it was determined that after installing the insert on the rib using a cantilever, the residual deformation on the rib was 0.016 mm for a rectangle, 0.05 mm for a triangle, and 0.08 mm for a circle (Figs. 6…8).

Thus, since the maximum bending of the rib in the vertical direction is 0.08 mm, and in the horizontal direction - 0.27 mm, after the insert is installed on the rib, the permanent deformation in the rib is 0.016 mm. It was found that the rational shape of the ends of the insert is rectangular.

CONCLUSIONS

Theoretical calculations and experimental studies made it possible to determine the deflection of the rib during the installation of the insert (of cantilever and two-support types) into the rib. The values of the permanent deformation on the rib after installing the insert are: in the form of a rectangle - 0.016 mm, of a triangle - 0.05 mm, and of a circle - 0.08 mm. Therefore, the rational shape of the ends of the insert is rectangular.

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