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O.V. Gavrilchenko, VM Zakharov
Lviv National Polytechnic University
Department of Mechanics and Automation Engineering

OVERLAP COEFFICIENT FOR PLACING ROUND-SHAPED DETAILS PROCESSED ON THE VIBRATION DEVELOPMENT MACHINE TOOLS DETERMINING

Описаний принцип обрахування коефіцієнта перекриття для деталей круглої форми.

The principle of overlap coefficient calculation for round-shaped details has been.

Problem statement. A controlled lapping process with increasing productivity of finishing equipment, precision and quality of details processing is a major challenge in the development of new advanced methods of finishing processes that provide highly accurate flat surfaces of both details that are processed and laps.

Vibration lapping is considered to be one of the promising methods of abrasive processing, which allows providing a surface roughness from 0.04 to 0.02 microns with flatness deviation from 0.1 to 0.01 microns.

Development of technologies for manufacturing processes that ensure high precision flat surfaces of both details that are processed and laps is an important area of finishing abrasive lapping.

This has led to theoretical studies due to insufficient depth study of the materials used for lapping and to improvement of technological processes that are being developed.

Designs of the vibration development machines with a circular trajectory of lap oscillations provide equal velocity of all points of the working surface, so wearing of work surface of laps as well as processed details can only depend on the time of their contact.

Relevance of improvement of technological processes that are being developed includes developing techniques of details placing that provide uniform wearing of surfaces of both laps and details and significantly increases the output parameters of the process of lapping.

Analysis of recent research and publications. The issue of processing details on vibration development machine tools is found in the works [1-5] of domestic and foreign scholars. In these issues of improvement the accuracy and efficiency of the lapping process, ensuring even wearing of the working surfaces and laps and development of various modern designs and processes that are used in abrasive lapping have been discussed. Particular attention is paid to maintaining flatness and uniform wearing of flat surfaces of finishing laps and details in time using:

– Lap trueing with the truers;
– Controlling the shape of the working surface of laps during the process by a programmable motion of components on the lap’s surface;
– The use of kinematic trueing when the original shape of the working surface of laps is kept by trueing the processed details.

Purpose of the study. Purpose of this work is to adjust optimization of lapping process on vibration development machine tools with circular trajectory of lap oscillations and to ensure uniform wearing of the details to be processed as well as the laps, when details must be closely positioned in the circular sector on the working surface of laps [1].

Kinematic trueing is considered the most promising method to provide lapping process parameters through the control of the shape of the lap’s working surface during lapping and maintaining its uniform wear over time and across the width.

The main material. This purpose can be achieved by placing the details being processed in accordance with the methods in papers [2, 3] on the lap's surface bounded by a circular sector.

Details are placed on the working surface of laps in circular sector so that they would touch one another on the outside diameter, as shown in Figure 1.

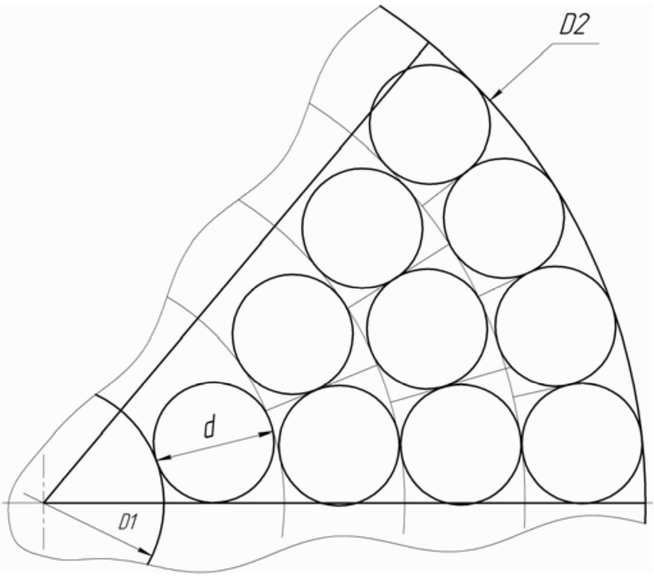


Fig. 1. Details placing on the working surface of laps with no overlap in the radial directio: D1 – lap inner diameter, D2 – lap outer diameter, d – detail diameter

Such location in the circular sector, on a working surface of lap forms a cavity between the details of various geometric shapes, in center to center direction as well as in the radial direction. This leads to uneven wearing and disproportionate constant contact time between the details and the working surface of laps because conditions [2] are not provided.

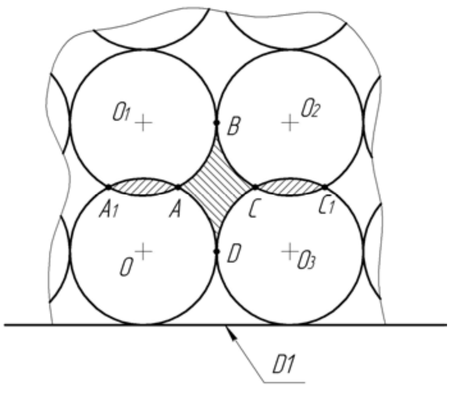


Fig. 2. Details placing with regard to the coefficient of overlap in the radial direction

To compensate influence of cavities between the details, they need to be placed with some overlap in radial direction from the center of lap as shown in Figure 2.

The magnitude and method of calculation of the details overlap in radial direction for round details will be determined by considering Figure 3.

Details are placed on the working surface of laps in circular sector so that they would touch one another on the outside diameter. This placement in circular sector forms a cavity between the details of various geometric shapes, as shown in Figure 3a and Fig. 3b, in the center to center direction as well as in the radial direction. This leads to failure of conditions [2] to ensure a constant contact time during grinding and to uneven wearing.

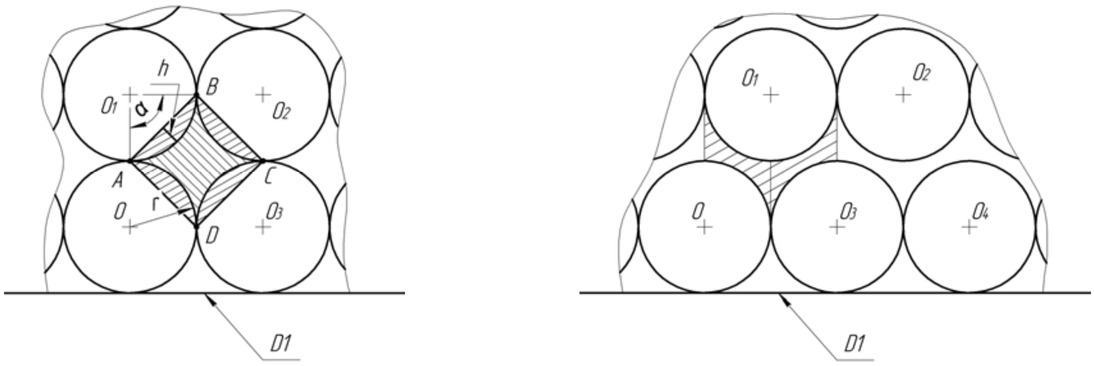
To ensure the compensation of influence of these cavities between the details, they need to be placed with overlap in the radial direction. For this purpose, the shape formed between four details, as shown in Figure 3 should be considered.

As shown in Figure 3, ideally, contact of four details would form a square ABCD with the side $r\sqrt{2}$ as the figure inscribed in a circle of radius r.

According to the Pythagorean Theorem area of the square ABCD is equal to:

$$S_{\text{кв}} = r\sqrt{2} \cdot r\sqrt{2} = 2r^2 \tag{1}$$

Area of segments formed by the intersection of sides of the square ABCD with details being processed should be calculated.



a *b*

*Fig. 3. Shape of four details contact^*
r – detail radius, h – height of the segment, α – sector angle

The area of one segment is equal to:

$$S_{\text{сегм}} = \frac{1}{2} \cdot r^2 \cdot \left(\pi \cdot \frac{\alpha}{180^\circ} - sin\alpha\right) = \frac{1}{2} \cdot r^2 \cdot \left(\pi \cdot \frac{90^\circ}{180^\circ} - sin90^\circ\right) = 0{,}285r^2 \qquad (2)$$

Area of four segments is equal to:

$$4 \cdot S_{\text{сегм}} = 4 \cdot 0{,}285r^2 = 1{,}14r^2 \qquad (3)$$

Now it is possible to calculate area of the cavity between details by subtracting area of four segments from area of the square ABCD:

$$S_{\text{пор}} = S_{\text{кв}} - 4 \cdot S_{\text{сегм}} = 2r^2 - 1{,}14r^2 = 0{,}86r^2 \qquad (4)$$

From the formula for calculating area of cavity between the details can be concluded that this area depends on the radius of details being processed.

For compensating influence of cavity area between the details on the wearing uniformity of details and laps, the area of overlap which is equal to the area of four segments in the radial direction, formed by the overlapping of details should be equal to 0,86 r^2.

The area of one segment will be equal to:

$$S_{\text{сегм}} = 0{,}86r^2/4 = 0{,}215r^2 \qquad (5)$$

Having the identity of area of calculated and arbitrary segment it is possible to calculate angle α of segment with an area of 0,215 r^2:

$$0{,}215r^2 = \frac{1}{2} \cdot r^2 \cdot \left(\pi \cdot \frac{\alpha}{180^\circ} - sin\alpha\right), \qquad (6)$$

From this identity $\alpha = 81^\circ$

Now it is possible to calculate the height of segment *h* depending on the radius of the detail:

$$h = r \cdot (1 - cos\,\alpha/2) = r \cdot (1 - cos\,81^\circ/2) = 0{,}239r \qquad (7)$$

as shown in Figure 2.

Conclusions. The results of the calculations are following:

1. To ensure uniformity of wearing, overlap coefficient of details in radial direction should be 0.239 of the radius of details being processed.

2. To significantly increase output process parameters of vibration lapping one should put compensators on the peripheral areas of laps in accordance with the proposed method [1].

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В.М. Корендій
Національний університет “Львівська політехніка”,
кафедра механіки та автоматизації машинобудування

РОЗРАХУНОК ХВОСТОВОГО СТАБІЛІЗАТОРА ДЛЯ ОРІЄНТАЦІЇ ВІТРОКОЛЕСА ЗА НАПРЯМКОМ ВІТРУ

Проаналізовано схему дії аеродинамічних сил на площини вітроколеса і хвостового стабілізатора при косому обдуванні. На основі експериментальних досліджень встановлено аналітичні залежності їх зміни у разі зміни швидкості й напрямку повітряного потоку та частоти обертання вітроколеса. Наведено та реалізовано методику визначення геометричних параметрів хвостового стабілізатора для забезпечення необхідної точності орієнтації.

The scheme of aerodynamic forces influence on the planes of wind-wheel and tail vane under sidelong air blow is analyzed. The analytical dependency of their changing after the changing of air flow speed and direction and wind-wheel rotation frequency is established on the basis of experimental research. The procedure of tail vane geometrical parameters determination is presented and realized for required orientation precision assurance.

Постановка проблеми. Кількість енергії, яку здатне відібрати вітроколесо (ВК) з потоку повітря, залежить від його положення відносно напрямку цього потоку. Вітрова турбіна (ВТ) розвиває максимальну потужність тільки тоді, коли площина обертання ВК розміщується перпендикулярно до напрямку вітру. За будь-яких відхилень ВК від напрямку вітру потужність, яку воно здатне розвинути, зменшується пропорційно до куба косинуса кута відхилення. У зв’язку з тим, що напрямок вітру безперервно змінюється, необхідно автоматично встановлювати площину обертання ВК перпендикулярно