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DEVIATIONS OF WORKPIECE CLAMPING AS FACTOR HAVING INFLUENCE ON ACCURACY OF A SURFACE MACHINED

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ABSTRACT: The paper deals with some questions regarding workpiece clamping in fixtures from the point of view of production inaccuracies. These inaccuracies consist of deviation of medium economical accuracy, deviation of seating and deviation of the fixture. The final achievable workpiece accuracy depends on the components of the mentioned deviations. The paper describes influence of the support point choice on deviation extend of the surface machined. Way for workpiece seating deviation calculation is given in the paper when the workpiece seats on various supporting points.
KEYWORDS: seating deviation, non-identity deviation, clamping deviation, basic positioning surface, basic dimensional surface, supporting element

❖ INTRODUCTION

We usually meet great amount of products different in shape and in their dimensions within engineering production praxis. The requirements on workpiece accuracy, and such way also on workpiece seating are permanently higher. For that reason it is important to appreciate suitability of the clamping equipment design for each actual case. Among various factors influencing the final achievable accuracy of the surface machined belong primary inaccuracies brought into production process.

❖ DEVIATIONS INFLUENCE ON DIMENSIONAL ACCURACY OF THE SURFACE MACHINED

Various requirements concerning accuracy of the individual surfaces machined are set by designer for components production. Possibility to achieve the required dimensional accuracy for the concrete component depends on more factors. The important factor having influence on accuracy of the surface machined is way of workpiece positioning and its clamping in fixture. Another factor is the accuracy of fixture positioning within machine tool. The accuracy of the final dimension also depends on values of cutting parameters chosen for machining, on stiffness of the entire system and on accuracy of mutual position between tool and workpiece. The said factors generate great amount of deviations, which can be divided into following three deviation groups:

- deviation of medium economical accuracy s,
- seating deviation ε,
- fixture device deviation ε_p

The required dimension accuracy v given by dimension tolerance T_v prescribed in drawing is stipulated by the formula:

$$T_v \geq \sqrt{\varepsilon^2 + s^2} + \varepsilon_p \tag{1}$$

Value of the deviation of medium economical accuracy s is usually obtained by practical experiences and is elaborated for individual technological machining techniques of various surfaces. Requirement for economical production is considered within this deviation, because to close tolerances can cause inadequately high production costs connected with surface machined and to cause increase of the final product price.

So as to find out the deviation of the fixture device ε_p for the concrete workpiece it is to find out the individual components which are part of the total deviation. The deviation of the fixture device consists of sum of the clamping deviation ε_{py}, the deviation of fixture positioning within machine tool ε_{po}, the deviation of tool adjustment ε_{pn} and of the dividing device deviation ε_{pd}. So value of the fixture device deviation can be calculated as:

$$\varepsilon_p = \varepsilon_{py} + \varepsilon_{po} + \varepsilon_{pn} + \varepsilon_{pd} \tag{2}$$

The seating deviation is to be taken as:

$$\varepsilon = \varepsilon_n + \varepsilon_s \tag{3}$$

where: ε_s - means the deviation (value) by which the produced dimension is modified as influence of workpiece seating through support surface, ε_n - means the non-identity deviation of the basic positioning surface against basic dimensional surface, when it is to be taken as:

$$\varepsilon_n = \sum_{i=1}^{n} T_{zi} \cos\beta_i \tag{4}$$

where: T_{zi} - means tolerance of the distance between positioning and basic dimensional surface; $cos\beta_i$ - means angle between perpendicular line of the positioning surface and perpendicular line of the surface machined.

❖ SUPPORTING ELEMENT INFLUENCE ON DEVIATION OF THE DIMENSION PRODUCED

An important decision step is choice of the clamping and positioning surfaces of the workpiece. In the end, this step influences achievement of the required dimensional accuracy of the surface machined. It is to take into consideration the basic dimensional surface, i.e. the surface from which the distance required machined surface is given on the drawing, when making decision, which surface should be taken as positioning surface. The most common cases of workpiece seating in the fixture are when the positioning workpiece surface is:

- ☐ plane,
- ☐ external cylindrical surface,
- ☐ cylindrical opening.

When a prismatic component is positioned on two parallel stepped planes (Fig. 1), the deviation of supporting elements ε_e occurs because of allowed workpiece inaccuracies an because of shape of fixture supporting elements. The component of the deviation ε_e into direction of the dimension produced is ε_s. In this case means:

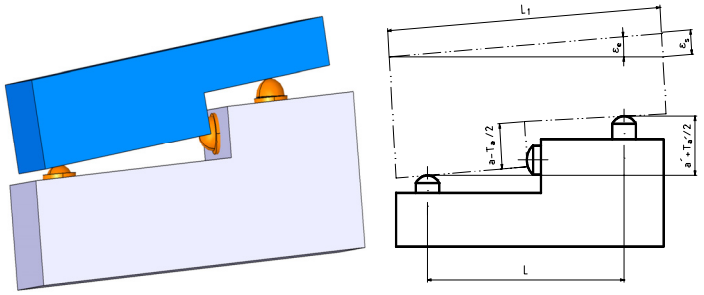

Fig. 1. Prismatic component on two paralel stepped planes

$$\varepsilon_s = L_1 \tan\varepsilon_e \tag{5}$$

When positioning is made through cylindrical opening, the line contact between supporting elements and workpiece comes into existence. Value of the deviation ε_s is given as:

$$\varepsilon_s = \varepsilon_e = \Delta + T_d + T_{d'} \tag{6}$$

When a cylindrical surface is positioned in a prismatic support, the supporting contact is made through two straight lines. The value of the deviation ε_s depends on the dimensional basis. The said basis can be axis of the positioning surface or creating line of the rotary profile (Fig.2). For the first mentioned case means:

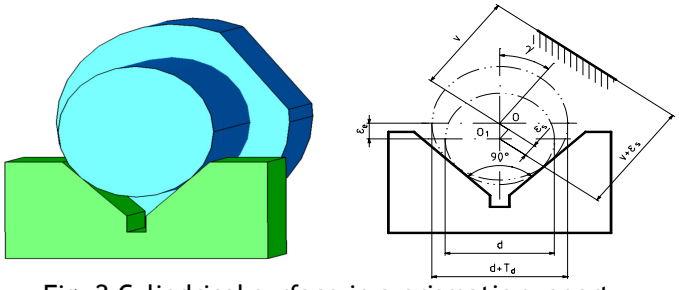

Fig. 2 Cylindrical surface in a prismatic support

$$\varepsilon_s = \frac{T_d \cos\gamma}{2\sin\frac{\alpha}{2}} \tag{7}$$

The influence of the maximal deviation of machined surface distance on the surface angle of inclination and on choice of the basic dimensional surface is shown on workpiece positioned in prism. The results are summarised in the table 1.

Table 1

Positioning deviation ε_{max} for φ40h8 and prism angel α=90° [mm]			
Inclination angle of the surface machined γ	Basic dimensional surface		
	More distanced creating line of the positioning surface	Axis of the positioning surface	Les distanced creating line of the positioning surface
0°	0,008077	0,027577	0,047077
15°	0,007137	0,026637	0,046137
30°	0,004382	0,023882	0,043382
45°	0,000000	0,019500	0,039000
60°	0,005711	0,013788	0,033288

❖ CONCLUSION

The proper design and construction of some clamping or fixing devices is not so simple task. Such equipment should meet many various requirements, which can influence its proper function and utilization. That is why it is to take into consideration and to analyze which requirements are the most important ones and in this connection decide which deviations should be mineralized primary.

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