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Measurement on the Plate-Measuring Machine

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Annotation. The models obtained by various methods must be compared with a real wheel in order to determine how correct its construction is, and this formed the basis of the article.

Keywords: plate-measuring machine, software, part, contact probe, calibration sphere, sliced wheel, basing, worm wheel, wheel model.

Models obtained by various methods must be compared with a real wheel in order to determine how correct the construction is. The comparison will be carried out on an EOS3 REINSHAW plate-measuring machine. The machine consists of a base, a portal, a measuring tool (Fig. 1). The measuring tool includes a rotary motorized head and a contact probe. The measuring tool moves along three axes - X, Y, Z. It can be moves both along one axis and several at the same time. To measure parts of complex shape, the angle of inclination of the measuring head can be changed. The principle of operation of the machine is to touch the blank with a contact probe. In the moment of touching, the software fixes the coordinates of the point. In the case of measuring any geometric element, the software makes a calculation. The software used is PowerInspect.

The machine is designed to compare a part with a drawing or a mathematical model [1; 2]. In this case, we will act vice-versa – to compare mathematical models with a part.

Probes of various sizes are supplied with the coordinate measuring machine. The touch probe is a very important part of the measuring system, since it is this probe that is exposed to the blank and triggers the sensor. The type and size of the stylus is determined by the part being measured. Since it is necessary to measure points on the worm wheel cavity, it is necessary to select a feeler gauge so that it can access the entire surface of the worm wheel cavity. Therefore, we will use a straight probe 15 mm long, 1 mm in diameter.

Before measuring a part, the probe must be calibrated to obtain reliable results. The reference part is a calibration sphere. First, to set the angles of the measuring head to zero, then touch the stylus to the top of the calibration sphere. After that, the calibration process begins.

An important stage of measurements is the choice of part basing. When using a plate-measuring machine, the difficulty also lies in matching the measured surfaces of the real part and the mathematical model. There are several types of basing in PowerInspect - PPT basing (plane, line, point), arbitrary basing, tri-sphere basing, optimal alignment basing, relative positioning system (RPO) basing, point cloud basing. The most optimal for this measurement is the Basing SOP. It is a very precise method of basing using selected XYZ values from the geometry. We will use basing 3-2-1

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Measuring tool // portal // base

Fig. 1. Plate-measuring machine.

Any rigid body in three-dimensional space has six degrees of freedom. Accordingly, its position can be determined using three coordinates describing the movement relative to (X, Y, Z) and three coordinates describing the rotation around these axes. To base a part, it is necessary to fix its movements along all axes. In basing 3-2-1 one element limits three coordinates, the second two coordinates, the third one coordinate.

Basing will be carried out on a plane, the center of the circle and a point on the surface of the worm wheel. Two types of use of the plane in basing are possible. The first is to lock the direction in which the orientation of the plane is fixed with the two axes of rotation locked. The second is to lock the position in which the orientation of the plane and its position along the axis are fixed. A fixed direction will be used. In this case, the center of the circle limits in three coordinates, the plane in two, a point on the surface of the depression in one coordinate (Table 1).

Bounding Objects

Table 1

Element	**Rotation axes**	**Offset axes**
Plane	X, Z	-
Center of the circle	-	X, Y, Z
Dot	Y	-

We install the cut wheel in a prism (Fig. 2). It is necessary to measure a plane, a circle, a point.

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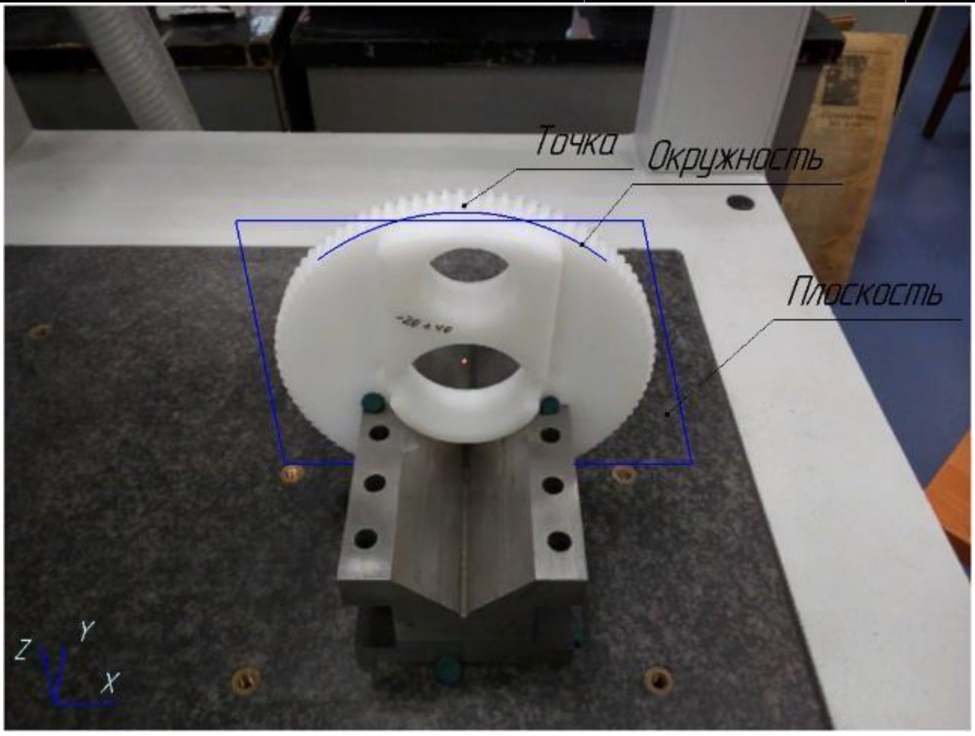

Fig. 2. Installing the wheel for measurement.

To create a basing, creation of the geometric elements that will define it is needed. Then select SOP Base on the Base toolbar. The SOP Base Definition dialog will open (Fig. 3). In the drop-down list, select the bounding element - plane 3, circle 2 center, DP1, then click OK.

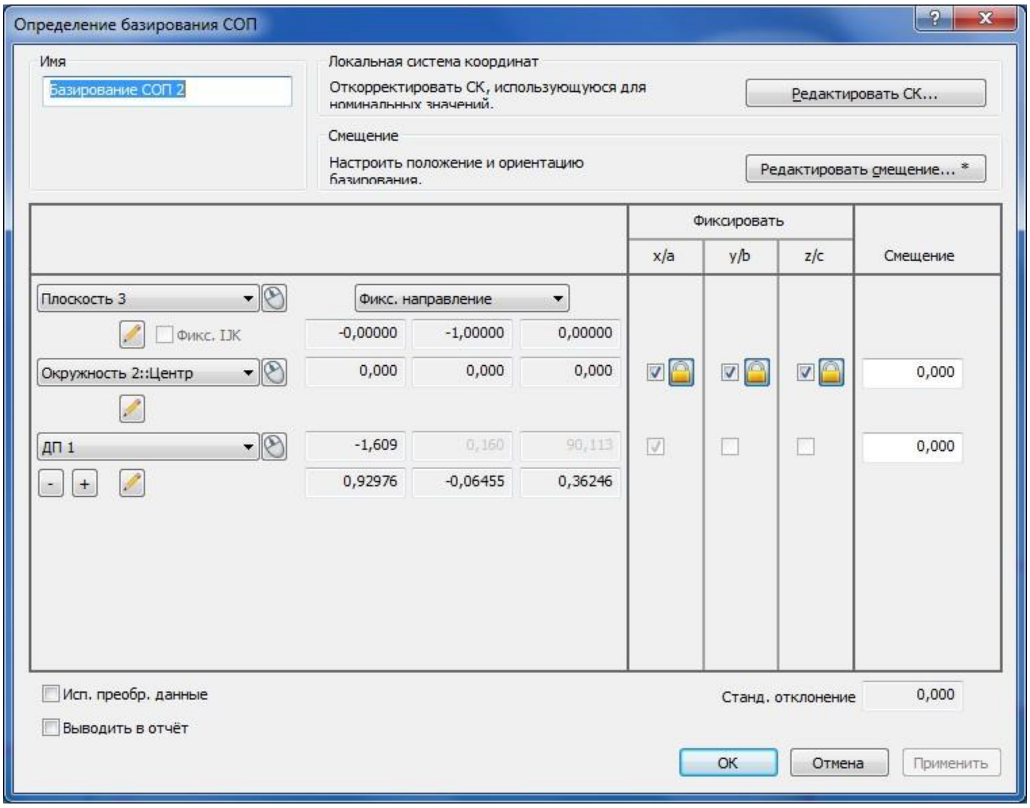

Fig.3. Definition of basing

After determining the basing, it is necessary to measure the elements included in it. The measurement

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takes place by manually moving the probe. When the probe touches the surface, it automatically retracts. A minimum of three points is required to define a plane (Fig. 4). If the required number of geometric elements is available, the software builds a plane. Fig. 5 shows the measurement of the last element, i.e. point DP1. The plane and the circle have already been calculated, the touch points are marked with green confetti.

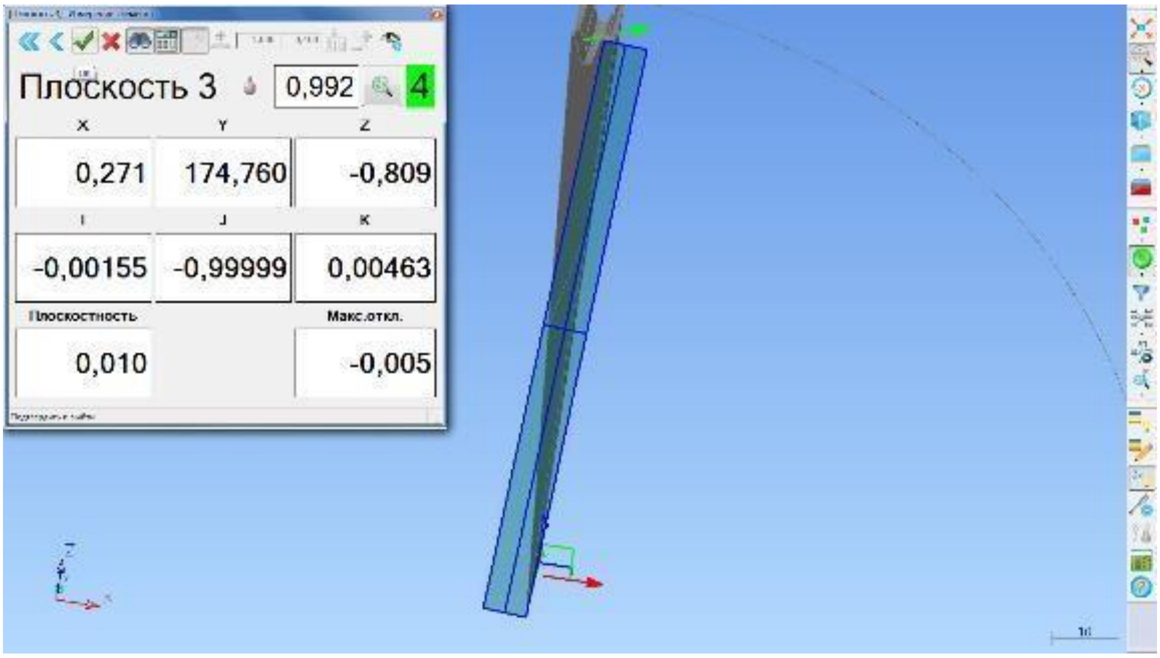

Fig. 4. Measurement of the reference plane.

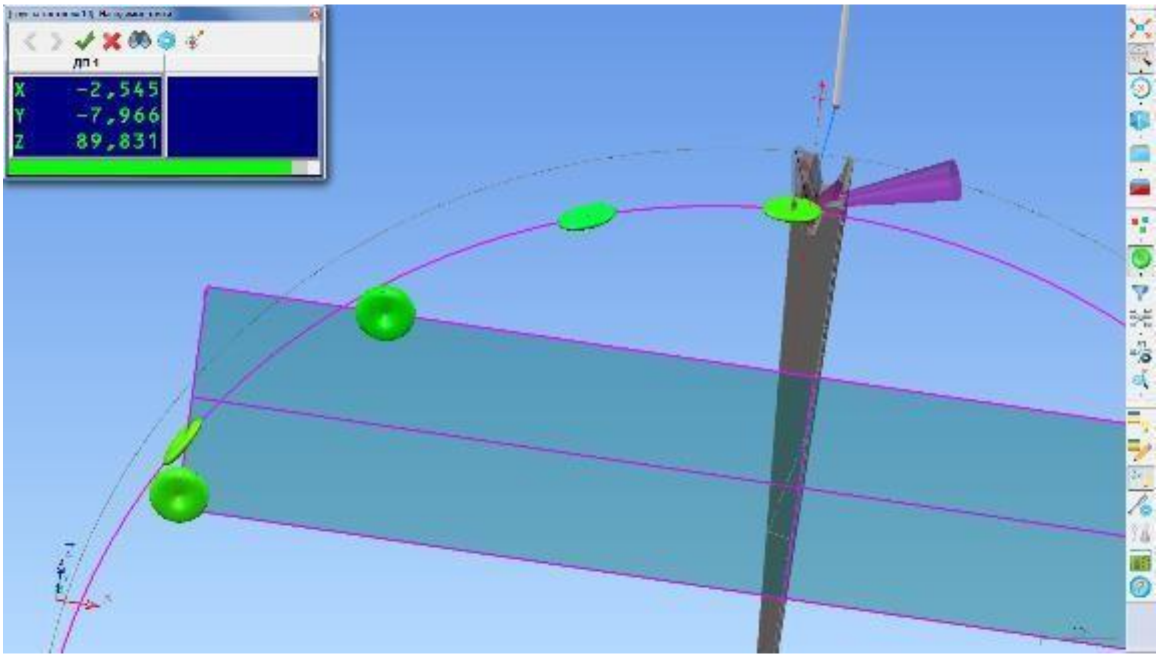

Fig. 4. Measurement of the base point DP1.

After measuring all the geometric elements, it may be necessary to rotate the mathematical model around the Y-axis to align the DP1 point on the measured wheel and the mathematical model.

To simplify the designations, we assign wheel models numbers 1-4 (Table 2)

Designations of the developed models

Table 2

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1	Worm wheel model generated in *COMPASS-3D*
2	Worm wheel model built using basic involute gear formulas
3	Worm wheel model obtained by kinematic cut of a set of cutter sections
4	Worm wheel model obtained by subtracting the worm body

To control the lateral surface of the tooth, we will create a group of point clouds. The number of measured points is 60. Since it is necessary to measure the deviations of the mathematical model from the real wheel, it is necessary to create a control group in which the point cloud will be located.

Four models of the wheel were checked on a plate-measuring machine for compliance with a real worm wheel. The models obtained by the first two methods do not provide the correct geometry of the cavity surface. This is because that the calculation of the curve forming the lateral surface of the tooth was carried out only for one central section. To obtain the correct surface of the cavity of the worm wheel, it is necessary to imitate the rolling method. For models of worm wheels designed in this way, the average deviation from the real wheel is 0.051 mm for the wheel obtained by subtraction of flat sections and 0.089 mm for the worm body obtained by subtraction. Based on the possibility of reducing the complexity for further work, we select a wheel model built by subtracting the body of the worm.

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