# THE METHOD AND THEORY OF TURN BACK POINT ERROR

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## ABSTRACT

This paper described the theoretical basis of extreme Value orientation in detail, which is used to examine the dimension of hole and axle with double point one coordinate measure instrument, and it's quality and feature and calculation method of survey error on dimension, which is caused by turn back point error, The paper also provide a practical chart, which is used to revise at the same time also introduced the study method which is designed by author;

**Key words:** Two point and one coordinate measure instrument, turn back point error; Orientation.

## 1. GENERALIZATION

Double measuring points and single coordinates instruments of geometric element gauge is the most common used precision instrument. The design of measuring method of these instruments is fundamentally based on orientation by extreme value criterion, that is, in measuring direction, there exists extreme on the size-line of measured parameter, because of this orientation method, all these instruments assemble universal bed. When measured parts was fitted on the universal bed, they have five freedoms, so can move to and fro, left and right, up and down, horizontal and vertical so on. Which makes it convenient to find the extreme value on the transversal and axial of measured parts. The whole process of finding extreme value is completed under surveillance of reading meter of the instrument. Find turn back point from the reading meter is label of finding extreme value.

It is analyzed in this text that theoretical base of extreme value existence and its nature, also it describes turn back point error which was created by transfer mechanism error of the bed, reading error from reading meter, and surface roughness of measured parts, and also it relates size measuring error by positional error of turn back point. Experimental research method of turn back point error designed by the author is also included in the text.

## 2.THEORETICAL BASE OF TURN BACK POINT

If there exists residual deviant $\Delta C$ in the cross section of measured aperture, the following formula is given(shows in fig 1):

$$(R_X - \delta)^2 = \left(\frac{\delta}{2}\right)^2 + \Delta C^2$$

$$\frac{s^2}{[2(R_X-\delta)]^2}+\frac{\Delta C^2}{(R_X-\delta)^2}=1 \qquad (1)$$

This formula is probability equation (shows in fig.3), so we can get the following conclusions:

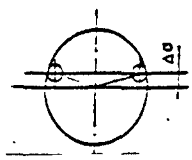

fig.1

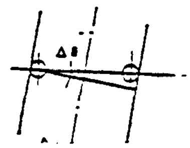

fig.2

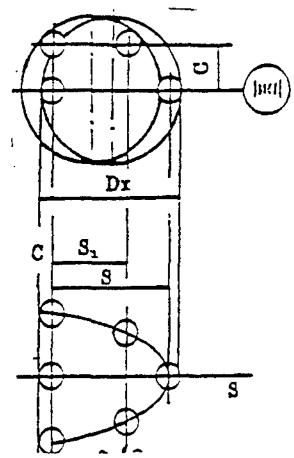


fig.3

1. Vertex of major axis $[2(R_x- r),0]$, we get the maximal value of size s. So this point is called turn back point at which point the detection error of measured aperture is 0.( $\delta_{DX}=0$)
2. When offset the turn back point ($C\neq0$), the detection error of measured aperture is :

$$\delta_{DX}=2\sqrt{(R_X-r)^2-Dc^2}-2(R_X-r) \qquad (2)$$

3. When $\Delta C<<D_X$

THE FORMULA:

$$\delta_{DX}=2(R_X-r)\left[1-\frac{\Delta C^2}{2(R_X-r)^2}-1\right]=\frac{-\Delta C^2}{R_X-r} \qquad (3)$$

The formula express that detection error is proportional to the deviant $\delta_c^2$ and inverse proportional to aperture ratio of the measured to the probe.

4. At vertex of major axis$[2(R_x-r,0]$, the radius of curvature is given as:

$$\rho=\frac{R_X-r}{2} \qquad (4)$$

So the sensitivity of extreme value method is limited in searching of turn back point.

5. When $\delta=0$, formula 3 can be simple as:

$$\delta_{DX}=\frac{\Delta C^2}{R_X} \qquad (5)$$

In the axial section of measured aperture, and the residual deviant of inclination being as: $\Delta\ \theta$ , the following formula is given.(fig.2 can be seen)

$$\delta = \frac{2(R_X - r)}{\cos\theta} \qquad (6)$$

The formula above is a periodic curve.(fig.5)

Conclusions

1. At curvilinear vertex, we get the maximal value of size s. So this point is called turn back point at which point the detection error of measured aperture is 0.(/ $\delta_{DX}$/=0) (7)

2.When offset the turn back point ( $\Delta C \neq 0$), the detection error of measured aperture is :

$$\delta_{DX} = 2(R_X - r)\left(\frac{1}{\cos\Delta\theta} - 1\right) \qquad (8)$$

3.When $\Delta\theta = 0$

$$\delta_{DX} = (R_X - r) \bullet \Delta\theta^2 \qquad (9)$$

THE FORMULA:

The formula express that detection error $\delta_{DX}$ is proportional to the inclination deviant $\Delta\theta^2$ and proportional to deviation between measured aperture and diameter of the probe.

4.At curvilinear vertex($R_x$,0) the radius of curvature is given as:

$$\rho = \frac{1}{2(R_X - r)} \qquad (10)$$

So the sensitivity of extreme value method is limited in searching of turn back point.

5.When $\delta = 0$ formula 8 can be simple as:

$$\delta_{DX} = R_X \bullet \Delta\theta^2 \qquad (11)$$

The things listed above is all about components of pore, to components of shaft generally use probe with axe formation (fig.4)

Width of its cutting edge is r.

Length is L.

In the transversal section of shaft, L=8. So it is easy to make $\Delta C=0$ . In the axial section, since h=1.5mm, inclination deviant is $\Delta\theta$ . Size detection error is:

$$\delta_{DX} = R_X \bullet \Delta\theta^2 + h \bullet \Delta\theta \qquad (12)$$

For there exists an item of $h\Delta\theta$ , the sensitivity in searching for turn back point is greatly improved.

## 3. CORECTION METHOD OF TURN BACK POINT ERROR

When the radius of probe r=0, detection error of the measured aperture created by residual deviant $\Delta C$ can be calculated through formula 5.

Fig.6 gives the detection error $\delta_{DX}$ when r=0 $\Delta C$=0.01~0.1mm $D_x$=10~100mm

Fig.7 gives the detection error $\delta_{DX}$ when r=0 $\Delta\theta$=0.1~1 $D_x$=10~100mm

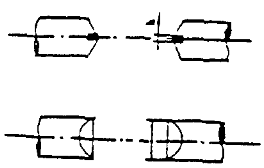

fig. 4

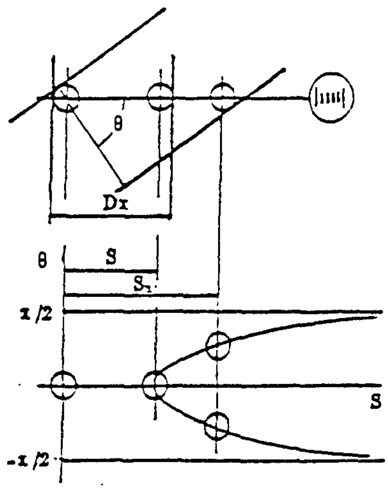


fig. 5

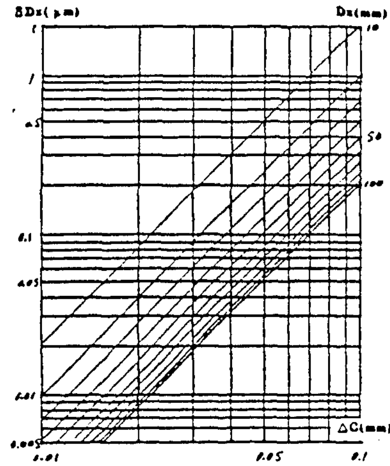


fig. 6

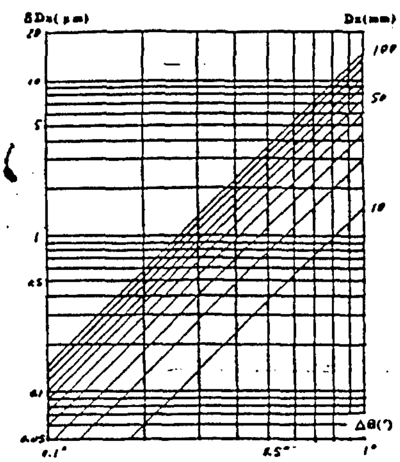


fig. 7