Design Analysis of Taper Gauges by using Catia V5

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***Abstract*—On the topic design of instruments, we have selected the topictaper gauges.A new instrument to measure bore diameter of any given specimen in a simple and precise manner. This instrument is named as "Taper Gauges" which is nothing but sets of tapered metal rods of some standard angles on which the measurements are made based on certain constants for that instruments depending upon the taper angle the work piece used. Taper gauges are the precise instruments to measure the bore diameter of any circular cross section with least count of 0.01 mm for 5.74° tapering. On decreasing the taper up to the angles of 1°, we can increase the precision of the instruments up to 0.001mm. Hence the accuracy will be more. Later it can be used on calipers for further improvements. Eventually it will be digitalized.**

I. INTRODUCTION

Measurement is the basis of all science and technology. Various measuring instruments have been developed over the past few decades. These measuring instruments are needed to be accurate and precise which should measure the values satisfactorily. In this case, Taper Gaugeis an instrument which is used to measure the inner bore diameter of a cylindrical cross-section in an effective manner. It has its least count in the range of 0.0002mm with negligible errors. It is highly accurate and precise with very appreciable cost.

The structure of taper Gauge is shown in Fig.1

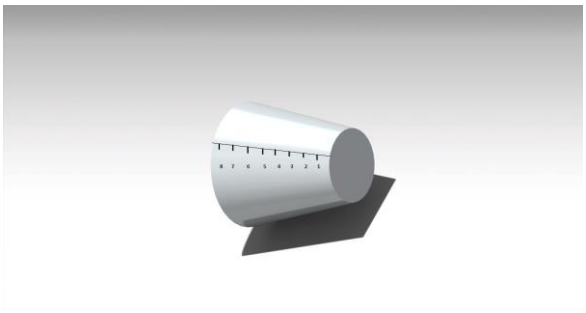


Fig. 1. Using Catia V5

Various Bore Measuring Instruments (existing):
a)Bore Angle
b)Pin Gauge
c)Dial Caliper
d)Internal Groove Vernier

A)Bore Gauge

Fig. 2. Bore Gauge

Bore Gauges are nothing but the telescopic gauges fitted with dial calipers to measure bore diameter. It is the most accurate and precise of all bore measuring instruments. Least count for this instrument is 0.001mm (or) 1 micrometer.

LeastCount=0.001mmAccuracy = ± 0.001mm.

B. Pin Gauge

Fig. 3. Pin Gauge

Pin Gauges are instruments used to measure the tolerance value of a cross-section in the range of 0.01mm.These instruments are very precise and accurate but very costly. It needs 100 set of pin gauges to measure 1mm of the diameter range. It has GO and NO GO ends to measure upper and lower values of the bore diameter.

Least Count = 0.01mm Accuracy = ± 0.01mm

C. Dial Calipers

Fig. 4. Dial Calipers

Dial Calipers are nothing but the mechanical comparators used to measure bore diameter. Its cost is moderate with least count 0.001mm.

Least Count = 0.01mm Accuracy = ± 0.01mm.

D. Internal Groove Vernier Calipers

Fig. 5. Internal Groove Vernier Caliper

Internal Groove Vernier Calipers are the bore measuring instruments used widely because of its low cost when compared to other measuring instruments**.**

Least Count = 0.02mm Accuracy = ±.02mm.

Now let us see the merits of using Taper Gauge, over the above discussed measuring instruments.

Taper Gauge

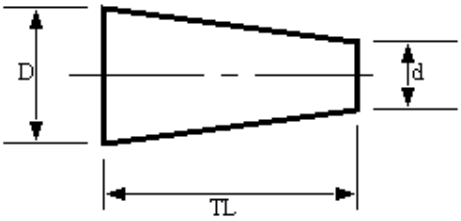
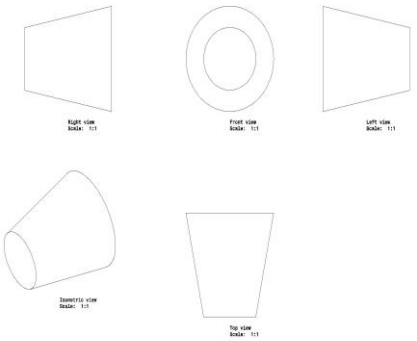


Fig. 6 Taper Gauge

In this series, we are introducing a new measuring instrument named Taper Gauge, which is more accurate and precise with low cost. Its working principle and tabulation of constants used for different taper gauges are shown as follows:

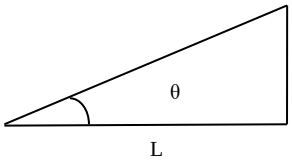
$$\frac{D-d}{2L} = \tan\theta$$

Different Views Of Taper Gauges Using catia V5:



II. DESIGN CALCULATION

It is designed on the relation,



To make the graduation in inclined tapered line, the value of the length is resolved as follows:

L=X cosθwhere L – length of the taper
X – inclined component of the length

The equation becomes as follows

$$\frac{D-d}{2X\cos\theta} = \tan\theta \quad \leftrightarrow \quad \frac{D-d}{2X} = \sin\theta$$

$$\frac{D-d}{X} = 2\sin\theta$$

Where 2sinθ = the constant for an instrument

Let X → least count of graduation in the measuring scale says 0.02 mm using vernier
D – d →least count for the taper gauge at a particular angle

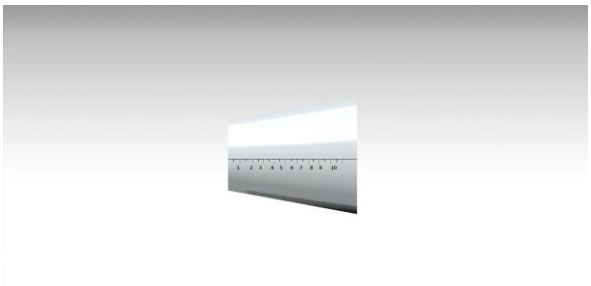


Fig. 7

On making different angles of the taper as per the tabulation Table.1, the various least count for those instruments can be found. On decreasing the angle of taper, the constant for the corresponding instruments decreases with the further decrease in its least count which gives higher accuracy and precision.

Table 1
Design Table for Taper Guage

Angle Of Taper (θ) Degree	Constnt Used(sinθ)	LeastCount (mm)		Error (µm)
		Without CaliperS	With Calipers	
30	0.5	0.5	0.02	nil
11.54	0.2	0.2	0.008	0.052
5.74	0.1	0.1	0.004	0.014
2.86	0.05	0.05	0.002	0.104
1.15	0.02	0.02	0.0008	0.069
0.57	0.01	0.01	0.0004	0.052
0.286	0.005	0.005	0.0002	0.0084
0.06	0.001	0.00025	0.00001	0.0052

Taper Gauge Sets

Like slip gauge sets, taper gauge has to be designed as sets so that the diameter of the cross section can be measured over the maximum range. Each taper gauge has the length up to 50mm so that it can measure the diameter ranges from
0 – 2mm for taper angle of 1.15°

$\frac{D-d}{2*50}$ = sin 1.15 where d = 0mm

D = 2 mm

Hence the instrument of 50 mm length can measure from 0 – 2 mm of the bore diameter. Hence the series of gauge sets can be made as that of slip gauges so that it can measure over the maximum range of values with high accuracy and precision.

Design For Calipers

Calipers used for taper gauges are thin hollow tapered sheet metals with greater stiffness and negligible cross section. It can change its maximum and minimum diameter at its ends so that the taper angle of the instrument and the length of the caliper remain constant.

While measuring, the calipers are made to slide over the graduation scale and at the reading points by simple lock nuts so that the least count of the measuring scale reduces to 0.02mm as that of the vernier calipers. Then the readings obtained from the gauge can be multiplied by that constant of the instrument as given in Table.1 to get the exact bore diameter.

For 1.46° taper gauge, least count = 0.0008mm = 0.8 microns

Comparison Over Above Instruments

The following table.2 makes the comparison of taper gauge over the bore measuring instruments listed above, which makes the taper gauge unique of other instruments.

Table 2

parameters	Bore Gauge	Pin Gauges	Dial Calipers	Internal Groove Vernier Calipers	Tape Gauge
Least Count	0.001mm	0.01mm	0.01mm	0.02mm	0.002-0.0002 mm
Accuracy	±0.001mm	±0.01mm	±0.01mm	±0.02mm	±0.0002 mm
Precision	High	High	Medium	Medium	Very High
Resolution	0.001mm	0.01mm	0.01mm	0.02mm	0.0002 mm
Cost	High	High	Moderate	Low	Low

Comparison between Measuring Instruments

III. CONCLUSION

Thus the design and the mechanism of usage of this new measuring instrument with its uniqueness and cost efficiency over the other measuring instruments are studied and illustrated. Hence the usage of taper gauge makes the process easier as it is the form of contacting instruments. It also needs low cost of manufacturing because of its simplicity and makes higher accuracy and precision with its very low least count.

IV. REFERENCES

[1] Inside Diameter Measurement - Mitutoyo. pdf
[2] Measuring And Gaging- archive.hnsa.org
[3] Manufacturing Technology .- Rajput