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Taper Measuring Setup

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***Abstract*:- The work carried out in this report concerns the demonstration of a taper measuring device, which works on an entirely different concept of, use of thread pitch for quick measurement of taper angle.**

The basic idea is to employ linear displacement of bolt to vary the vertical elevation of the frame on which the given object rests. This prototype enables the user to quickly measure the taper angle value without much manual labor. This is the prime advantage of this model over conventional methods of taper measurement like sine bar.

The report gives detailed explanation of various sections concerning the construction, working etc. of this prototype. The model with its reliable structure and provision for electronic devices promises greater future applications in various fields of measurement and quality control of different industrial products.

Key Words: Taper 1, Thread pitch2 etc…

1. INTRODUCTION

Various industries need various instruments to measure different aspects of the product geometry, e.g. length, volume, hardness, etc. One such important aspect is the taper angle of the object. Various methods and instruments are currently available to measure the taper angle of the given object viz., sine bar, CMM machine, etc. But some of these methods are tedious and consumes a lot of time while others are comparatively costlier. So we have come up with a device which not only measures the required taper angle but is also fast in operation with reasonable accuracy.

This device works on indirect measurement of taper angle with the help of vertical elevation of supporting frame and trigonometric relations. The most important advantage of this device over traditional methods is the ease of handling, operation and fast results.The report gives detailed information about various aspects of this prototype which promises greater future applications.

2. BACKGROUND

The process of taper measurement involves measurement of taper angle of the given drafted surface. Since, there is no direct method available for measuring this angle, we use the ratio of two different lengths concerning the taper angle and then with the use of trigonometry, the required angle can be obtained.

Conventional method of measuring this angle is the 'sine bar' [1]apparatus. Though this instrument gives fairly accurate measurement of required taper angle, it also consumes a considerable amount of time. With the proposed method this measurement time can be cut short to a great extent. This is the most important advantage of this prototype.

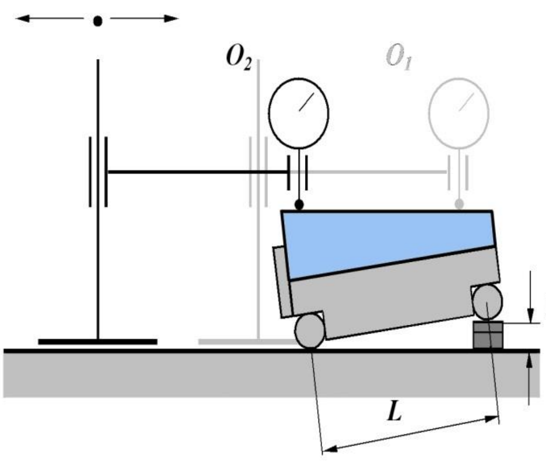

Fig -1: Sine bar – conventional method

3. TAPER ANGLE MEASUREMENT

The process of measurement of taper angle with the proposed device involves measurement of vertical height of elevation of the frame supporting the given object. Once the required height is obtained, which can be checked with the help of deflection probes, the angle made by the frame with the horizontal plane can be calculated by measuring the no. of turns given to the bolt.

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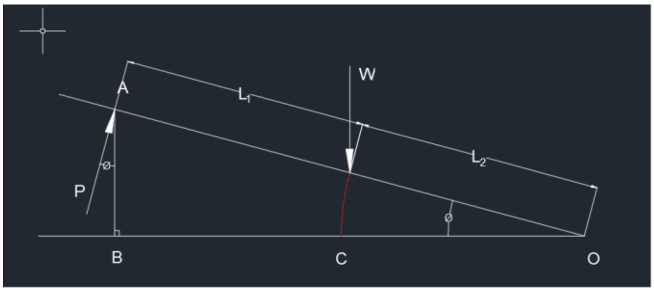

Fig -2: Operating Principle of TMC

The vertical height of the frame is controlled with the help of movement of bolt inside the nut. The nut is fixed to the bottom frame with the help of L-shaped metal plates. The nut serves two functions:

1) It confines the movement of operating bolt.

2) It supports the weight of the supporting frame and the object

The smooth movement of bolt inside the nut forms the basis for the working of the prototype. As shown in fig. 3, the length OB is fixed and is equal to 200 mm. Length AB is adjusted with the help of the operating bolt and is variable. L_1 and L_2 are the lengths of flaps on either side of the point through which weight W acts, whereas Ø is the required taper angle.

4. DESIGN

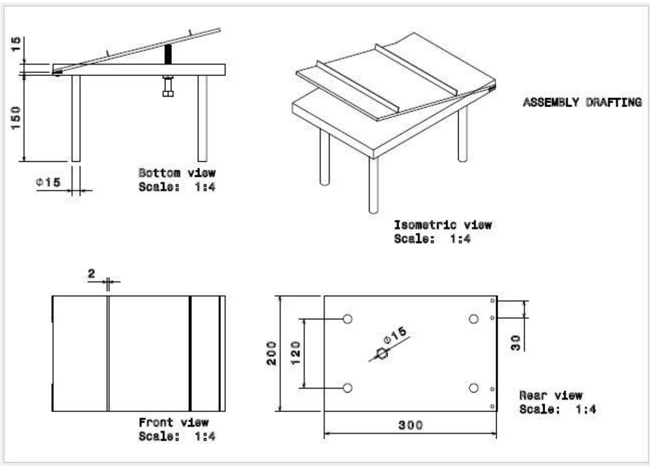

Fig-3 : Dimensions of various parts

The design of the entire prototype can be divided into two parts:

1) Bolt dimensions
2) Frame dimensions

The dimension of the bolt is selected so that the pitch of the bolt is appreciably low. For the constructed prototype, bolt with 6 mm nominal dia. is selected by virtue of its fine pitch and sufficient strength.

The frame dimension determines the allowable size of the object, the taper angle of which is to be measured. For convenience and ease of handling, the dimensions of the frame in this case are 200 × 300 mm

Provision for fastening of support metal plates and hinges are also made on the frame as shown in fig.3.

For ease of calculations and convenient positioning, the hole is drilled at a distance of 200 mm from the hinge end of the plates.

The nut is also centrally aligned with this hole.

This constitutes the dimensions of the various components involved in the given prototype.

5.CONSTRUCTION

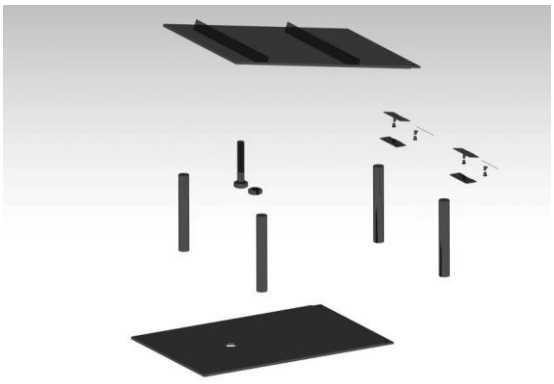

Fig-4 : Exploded view of Model

The construction of the model starts with the connection between two flaps with the help of hinges. To ensure the flat mating of two flaps, suitable notch is made in both the flaps. This provides proper alignment between the two flaps. The next step then is to drill the holes at various locations mentioned above to provide holes for bolts and supporting metal plates.To ensure that nut acts as support, the nut is welded to the L-shaped metal plates and these plates are then attached to the lower frame with the help of screws. This constitutes the construction of the bottom half of the model. The supporting frame located in the upper half, is hinged at one of the extreme ends with the help of hinges of suitable shape and size. In order to ensure proper fixing of these hinges to the lower frame, they are tightly screwed to the lower half frame and thus the movement of upper frame is confined. In order to securely confine the given object and prevent its sliding on the surface of upper flap, two supporting plates are also provided. Any suitable arrangement is acceptable in this case as it does not interfere with the measurement part of the device.

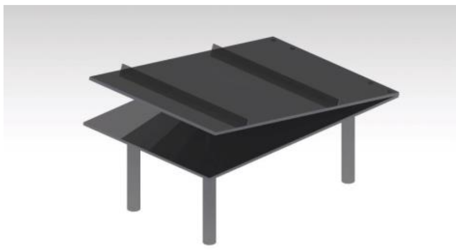

Fig-5 :Rendered Model

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6.ACTUAL MODEL

The difference between the actual model and the CAD model is that of the spring used to increase the accuracy of the device. The spring resists the compression as the bolt is turned into the nut and thereby facilitates fine adjustments.

Fig-6: Actual Model

Fig-7: Actual Model Consisting of Adjusting spring

7. MATERIAL AND COSTING

SR. NO.	PART	MATERIAL	QUANTITY	COST per no. (in Rs.)
1	Flaps	Wood	2	-
2	Support plates	Mild steel	4	40
3	Bolt	Steel	1	-
4	Hinges	Steel	2	50
5	Nut	Steel	1	-
6	L-shaped plates	Steel	2	10
7	Spring	Steel	1	20
			Total	300

Table-1: Material and Costing

8.TESTING AND PERFORMANCE

Sr No	Analytical				Experimental		% Error
-	L(mm)	D(mm)	d(mm)	θ(deg)	h(mm)	θ(deg)	-
1	80.68	30.0	18.34	4.1330	19.00	4.302	4.08
2	80.46	29.9	17.80	4.2700	18.50	4.180	2.10
3	80.46	30.0	18.00	4.2413	18.83	4.240	0.02
4	80.40	30.0	18.50	4.0700	18.00	4.074	0.09

Table-2: Measurement with Sine bar

Sr. No.	Pitch (mm)	No. of revolutions	Taper Angle (θ)	% Error
1	1	15+(11/12)	4.55	5.764
2	1	15+(8/12)	4.48	7.177
3	1	14	4.00	-5.660
4	1	15+(2/12)	4.33	6.284

Table-3: Measurement with TMC

8.1: Sample Calculations

For case 1), for TMS,

Vertical height obtained with bolt = AB

= [15+(11/12)] * 1 mm = 15.917 mm

Fixed horizontal length = OB = 200 mm

Therefore, taper angle = θ = $\tan^{-1}$ (15.917/200) = 4.55 deg

Average value of taper angle with sine bar: θ_{avg} = 4.199 deg

Average value of taper angle with TMS: θ_{avg} = 4.34 deg

% Error in both the avg. values = [(4.199-4.34)/4.199] * 100

= -3.35794

Therefore, the value of taper angle obtained with TMS is lesser than that obtained with sine bar by 3.358 %.

9.APPLICATIONS AND SCOPE

1. The taper angle of the given object can be easily and quickly measured.
2. Sine bar can be easily replaced with this device.
3. With the use of LVDTs, manual work is reduced.
4. With the use of probes, springs and LVDTs, accuracy can be increased to a great extent without affecting the time for measurement

10.RESULT AND ANALYSIS

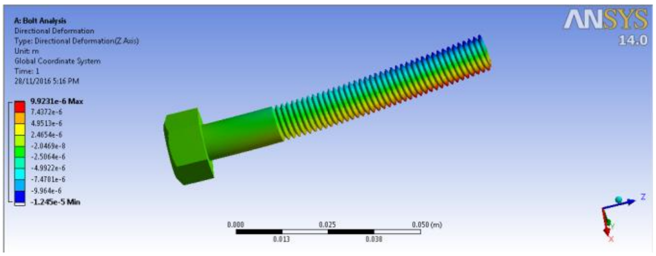

Fig-8: Deformation under applied forces

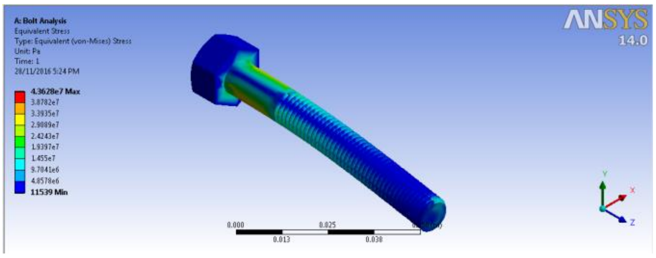

Fig-9: Stress distribution in operating bolt

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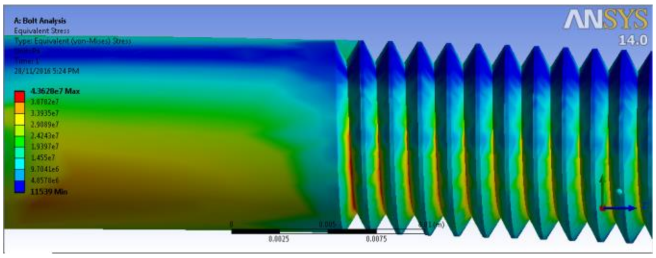

Fig-10: Region of maximum stress

The stress analysis given above clearly shows that the stress is maximum around the threaded region located near the half of the bolt close to its head. Whereas the its effects are less significant in the remaining half. The type of stress in this case is bending stress. Torsional stress is observed when the bolt is being rotated and that effect is momentary, and as it has less magnitude it is comparatively less significant.

11. CONCLUSIONS

The given report clearly indicates that, the 'Taper Measurement Setup' can be easily used for measurement of taper angle of given object.
The time for measurement is also considerably reduced and hence the setup is effective and can practically replace sine bar with fairly good accuracy.

ACKNOWLEDGEMENT

The authors can acknowledge any person/authorities in this section. This is not mandatory.

REFERENCES

[1]. https://en.wikipedia.org/wiki/Sine_bar

BIOGRAPHIES

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