Experiment No. 4

Title:-Measurement of Spur gear tooth parameters.

Specific Outcomes:- Students will able to

1) To know & identify the principle characteristics of gear.
2) To acquire the skill of measuring characteristics of gear with gear tooth Vernier.

Instruments/ Equipment with Specifications:-

1) Gear tooth Vernier.
   Vertical Vernier Slide- Range: Least Count: mm.
   Horizontal Vernier Slide- Range: Least Count: mm.
2) Vernier Calliper :
3) Bench vice:

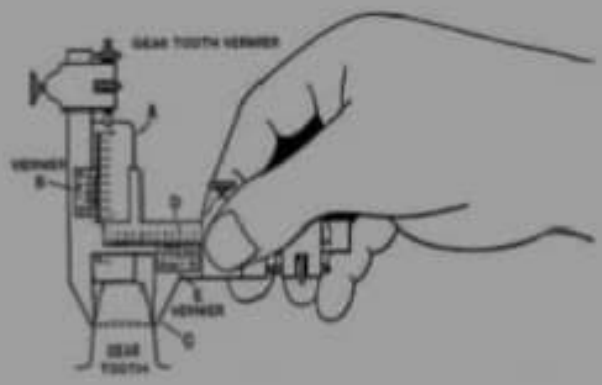

Fig.4.1 Gear tooth Vernier

Image Source:
https://etc.usf.edu/clipart/187000/187074/187074-tooth-vernier.htm

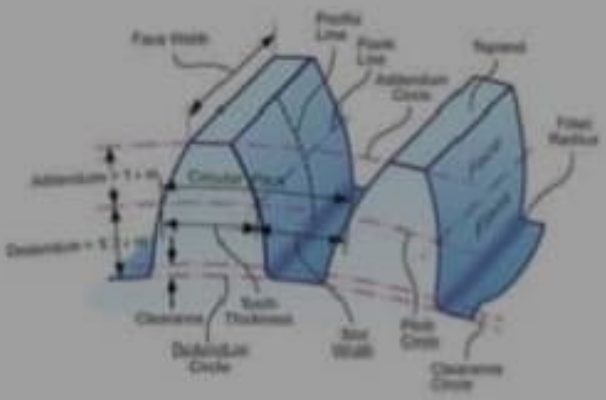

Fig.4.2 Spur Gear tooth profile

Image Source:
https://www.geartechnology.com/articles/0615/The_Basics_of_Gear_Theory/

Working Principle :-

Brief description of tooth thickness by gear tooth Vernier is given. It consists of a horizontal & a vertical slide. It based on the principle of Vernier scale. The thickness of a tooth at pitch line and the addendum is measured by an independent tongue each of which is adjusted independently by adjusting the slide screws on graduated beams.

Terminology :-

1) **Pitch Circle Diameter (P.C.D.):-** It is the diameter of the imaginary circle which by pure rolling action will produce the same motion as the actual gear. It is equal to

$$D = (T \times O.D.) \div (T + 2)$$

Where D = P.C.D., OD = Outside Diameter, T = No. of Teeth.

2) **Module (m)** :- It is a ratio of P.C.D. in mm to the No. of teeth.

$m = D \div T$

3) **Circular Pitch (C.P.)** :- It is the arc distance measured along the Circumference of the Pitch Circle from a point on one tooth to the corresponding point on the adjacent tooth.

$C.P. = \pi D \div T = \pi m$

4) **Addendum** : This is the radial distance from the pitch circle to the tip of tooth. It is equal to one module.

5) **Clearance** : - it's the radial distance from the tip of the tooth to the bottom of the mating tooth space when the teeth are symmetrically engaged.

Its standard value is 0.157m or 0.25m

6) **Dedendum** : This is the radial distance from the pitch circle to the bottom of tooth space. It is equal to 1.157 x module.

Dedendum = Addendum + Clearance = m + 0.157m = 1.157m

7) **Tooth Thickness** :- This is the arc distance measured along the Pitch Circle from the intercepts with one flank to the intercepts with the other flanks of the same tooth.

- Formula: $t' =$ (For chordal tooth thickness.)

- Formula: $c =$ (For chordal depth.)

Procedure :-

For finding P.C.D. , Module, addenedum, Dedendum, & Clearance :

1) First find the blank diameter (O.D.) by Vernier caliper and also count the Number of teeth, 'T' of the spur gear.
2) Calculate pitch Circle diameter (D).
3) Find addenedum, Dedendum, & Clearance, Pitch, Module as per formulae given in the terminology.

For Chordal Tooth thickness (using Gear tooth Vernier) :

1) Set the chordal depth (addendum) on the vertical slide of Gear tooth Vernier and then insert the jaws of the instrument on the tooth to be measured.
2) Adjust the horizontal Vernier slide by the fine adjustment screw so that the jaws just touch the tooth.
3) Read the horizontal Vernier slide and note the reading. It gives the chordal thickness of tooth.
4) Repeat the observation for different teeth.
5) Compare the values of different characteristics with the standard value and set the percentage error.

Observations & Calculations :-

Zero error of Horizontal Vernier slide =

Zero error of Vertical Vernier slide =

Batch No.	M1	M2	M3
Gear No.	Gear1	Gear2	Gear3
No. of teeth on Spur gear = T			
Pitch Circle Diameter (D) = (T X O.D.) ÷ (T + 2) (mm)			
Module (m) = D ÷ T (mm)			
Addendum = m. (mm)			
Dedendum = 1.157m. (mm)			
Clearance = 0.157m. (mm)			
Circular Pitch = π m. (mm)			
Tooth thickness of gear tooth = t (Measured) (mm)			
Standard value of chordal tooth thickness = t' (Calculated) (mm)			

Table for characteristics of spur gear tooth:-

Batch No.	M1	M2	M3
Gear No.	Gear1	Gear2	Gear3
No. of teeth			
Height/depth of tooth (c) (Calculated)			
Chordal tooth thickness (t') (Calculated)			
Chordal tooth thickness (t) (Measured by setting Height/depth)			
Difference (t' – t)			
Parentage Error = [100 X (t' – t)] ÷ t'			

Sources of error :-

1) The adjusting of jaws of gear tooth Calliper may not be proper.
2) Zero error may be there.
3) Jaws may be worn out.

Precautions:-

1) Gear surface should be cleaned properly before setting the instrument.
2) Zero error of the instrument should be taken into account.
3) Repeat the experiment by setting the instrument on different teeth.

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Observations and Calculations :-

Zero error of horizontal vernier side

Zero error of vertical vernier side

	Gear 3
Gear No.	28
No. of teeth on spur gear =	
Pitch circular Diameter (D) = (T x 0.D) ÷ (T ÷ 2) (mm)	56
Module (m) = D ÷ T	2
Addendum = m (mm)	2
Dedendum = 1.157 m (mm)	2.314 / 2.50
clearance = 0.157.	0.314 / 0.50
Circular pitch = π. m.	6.28
Tooth thickness of gear tooth (measured in (mm).	4.20
Standard values of chordal tooth thickness (mm).	3.70

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1. Gear thickness =
   ∴ MSR + (VSR * LC)
   4 + (10 * 0.002)
   = 4 + (0.20)
   = 4.20 mm.

2. Depth of Gear tooth.
   MSR + (VSR * LC)
   3 + (35.0 * 0.002)
   = 3.70 mm.

3. Pitch circular Diameter =
   D = (T x 0.D) + (T + 2)
   Where T = 28.
   D = [28 x 60/28 + 2]
   = [28 x 60/30]
   D = 56 mm.

4. Module
   M = D/T
   = 56/28
   = 2 mm.

5. Circular pitch (CP).
   CP = π/D/T
   but = D/T = m
   CP = πm
   = π x 2 = 6.28 mm.

6. Addendum
$= 1m \quad (m=2)$
$= 1 \times 2$
$= 2\ mm$

7. Clearance
$= 0.157 \times m$
$= 0.157 \times 2$
$= 0.314$

0.25×2
or $= 0.50$

8. Dedendum
= Addendum + clearance.
$= 2 + 0.314 \quad 2 + 0.314$
$= 2.314$

or $2 + 0.50$
$= 2.50$

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* Table characteristics of spur Gear tooth:

Batch no:	Gear 3
Gear no.	
No. of teeth	28
Height / Depth of tooth	
Chordal tooth thickness (t')	4.20 mm
Chordal tooth thickness (t) measured by setting (Height Gauge)	3.70 mm
Difference (t' − t)	0.50 mm
Percentag error = [100 x (t' − t)] ÷ t'	54.2 %

Depth of tooth = 2.25 x module

Chordal Depth tooth thickness = 1.5708 x module.

$$\text{chordal depth} = \frac{D}{2}\left(1-\cos\left(\frac{90}{T}\right)\right)$$

Depth of tooth = 2.25 x 2.

= 4.5 mm.

Chordal Depth tooth thickness = 1.5708 x 2

= 3.1416

$$\text{Chordal depth} = \frac{D}{2}\left(1-\cos\left(\frac{30}{T}\right)\right) \qquad \frac{60}{2}\left[1-\cos\left(\frac{30}{28}\right)\right.$$

$$= 30\left[1-\cos\left(\frac{30}{28}\right)\right.$$

$$= 1.7483 \times 10^{-4}.$$

Assignment:-

1) How gears are classified?
2) What are the applications of Gear Tooth Vernier Calliper?
3) How alignment test & concentricity test can be carried out on Spur Gear?
4) How runout checking is carried out?
5) How to check the involute profile of a tooth in transverse section of spur & helical gears?

References

Title of Article	Web Link
Experiment No. 12 : Measurement of Spur Gear Characteristics	http://egyankosh.ac.in/bitstream/123456789/27378/1/Experiments%281-20%29.pdf
Experiment No 6 Gear Tooth Vernier Caliper.	https://www.youtube.com/watch?v=X7PioNEvlMs
Measurement of Chordal Thickness Of Gear Tooth By Gear Tooth Vernier Caliper | PE LAB|	https://www.youtube.com/watch?v=suWlbCsIomg

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Assignment

1:- How gears are classified ?

Ans → Gears are mainly classified by their type and orientation of axes

i). Parallel axes gear

ii) . Intersecting axes gear

iii) . Non intresting axes

2. What are the applications of gear tooth vernier calliper?

Ans → Gear vernier calliper is mainly used to measure thickness of teeths of gears

It can also be used to measure job and tuned tools

3. How alligment test and concentricity test can be carried out on spur gear?

Ans → Alligment test is done by placing parallel bar between gear teeth and gear being mounted between centres. Finally readings are taken at two ends of bar and difference between readings and missalignment

Concentricity test is done by mounting the gear between centres and measuring the variation in height of roller placed between the sucessive teeth. Finally the variation in reading will be function of the eccentricity present

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4. How run-out checking is carried out?

Ans → Run-out means eccentricity in pitch circle. It will give periodic vibration during each revolution of gears.
Test is carried out by placing gears in mandrel and dial indicator of tester process special trip depending upon gear and the tip inserted between the tooth space and gears are rotated by tooth and variation is noted from dial indicator.

5. How to check involute profile of tooth transverse section of gear spur and helical gear?

Ans → In spur gear, fix the work gear and circular plate/disc which is same diameter of base circle of gear. Bring the base circle in contact of straight edge of instruments the allign probe stylus on first gear and in the middle of gear force. Rotate the gear with disc and edge over moves a circular disc without sleep. The pluger of dial indicator moves over the tooth profile and if there is any error is get display on play indicator.