Defining the Spline Pressure Angle

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QUESTION

I am a mechanical engineering student at the University of Kansas. I have a sprocket that has an internal spline. I am trying to design a mating gear with this internal spline.

After buying a sprocket online, I was able to make a CAD model with the help of someone who does reverse engineering on gears. From this CAD drawing, how do I calculate the pressure angle of this gear? And how do I design the mating gear (external splined gear) for this part?

***Expert response provided by* Dr. Hermann J. Stadtfeld:** (*Editor's note: For a more detailed presentation on this topic, look to the Sep–Oct issue for "Design Parameters for Internal Splines," by Dr. Stadtfeld.*) If the splines are being designed, then one of the preferred pressure angles from the standards should be used. ANSI and DIN offer the choice between 30°, 37.5° and 45°. In the JIS standard a pressure angle of 20° is also proposed.

If the spline is designed for an aftermarket product (for example, a sprocket or a spline shaft), then a simple measurement, preferably on a CMM or with a Vernier caliper as shown in the Figure, can be conducted to obtain a first pressure angle estimation. If the aftermarket product is the sprocket (not the shaft), then it would be desirable to obtain the measurement explained in the Figure on the spline shaft.

The measurement results are used together with the depth of the spline tooth to calculate the approximated pressure angle:

$$\alpha_{approx} = \arctan[2 \times Depth/(t_1 - t_2)]$$

In case of a topland $t_2 = 2.60$ mm, a root width $t_1 = 7.30$ and a Depth of 2.0 mm the approximated pressure angle is:

$$\alpha_{approx} = \arctan[2 \times 2.00/(7.30 - 2.60)] = 40.39°$$

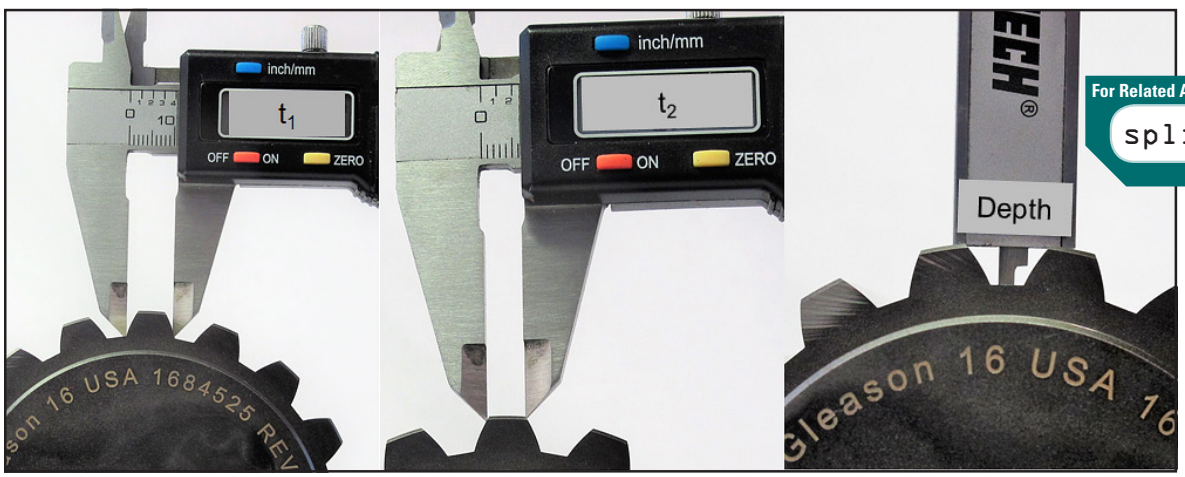
The approximated angle is between the preferred angle 37.5° and 45° from the standards. The difference to 45° is 4.61° and the difference to 37.5° is only 2.89°. The decision therefore is 37.5°:

$$\alpha_{External} = \alpha_{Internal} = 37.5°$$

37.5° is a popular pressure angle for splines which also indicates, that the result of measurement and calculation is realistic. It is recommended that the major diameter of the sprocket is equal to the outside diameter of the spline shaft to assure a major diameter fit. If the sprocket is the transmission output of a unidirectional unit, then the flanks can receive a small backlash (e.g. sprocket spline tooth thickness tolerance ISO 7H and shaft spline tooth thickness tolerance 7f). If sprocket and spline have to transmit torque in frequently changing direction, then a transition fit or a press fit of the spline teeth is recommended (sprocket ISO 7H, shaft ISO 7n.

The tolerance of the major diameter of the internal spline should be a selected as a transition fit for example ISO H7 (the outside diameter of the spline shaft should be ISO j7).

Dr. Stadtfeld is Gleason Vice President - Bevel Gear Technology - R&D.



Measurement of topland root and depth.

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