# Crowning Spur Teeth

## THE QUESTION

When designing spur teeth, is there a formula/guideline/design guide for determining the amount of crowning?

### Response provided by Octave LaBath.

In September 2005, I produced a spreadsheet comparing four references for crowning on parallel shaft gearing. I have since added a fifth reference:

### References on Crowning:


1. McVittie, Don. "Our Experts Discuss Hobbing Ridges, Crooked Gear Teeth and Crown Shaving," *Gear Technology*, March/April 1992, pp. 41-43.
2. Stokes, Alec. *High Performance Gear Design,* Machinery Publishing, 1970, p. 89.
3. Merrit, Henry Edward. *Gear Engineering,* John Wiley & Sons, 1972, p. 124.
4. Dudley, Darle, Ed. *Gear Handbook,* McGraw Hill, 1962, p. 5-24.
5. National Broach & Machine Division. *Modern Methods of Gear Manufacture,* Lear Siegler, Inc., p. 77.


### Example 1 (McVittie)

"The amount of crown is critical," McVittie says, "since too much total crown in the pair of gears will concentrate the contact into a narrow area of the face and lead to premature pitting failures. A reasonable rule of thumb is 'no more than .0003 to .0005 inch' of crown per inch of face."

Face 2.000" (50.8 mm)
Crown Minimum = Face • 0.0003 = 0.0006" (0.015 mm)
Maximum = Face • 0.0005 = 0.001" (0.025 mm)

Therefore the tooth thickness of a 2.0" face width gear would be 0.0012" to 0.0020" less than in the center of the face width.

### Example 2 (Stokes)

"For any power gearing application," Stokes says, "it is essential that perfect tooth contact is obtained. To allow for any misalignment in the mountings of the gears, or heat treatment distortion, it is usual to crown the tooth form, i.e., produce elliptoid teeth, thus eliminating any chance of end loading the gear tooth."

According to Stokes, crowning is usually .0002 to .0003 inches crowning per inch of face width, with a maximum of .0005 inches per inch of face width.

Face 2.000" (50.8 mm)
Crown Minimum = Face • 0.0002 = 0.0004" (0.010 mm)
Maximum = Face • 0.0005 = 0.0006" (0.015 mm)

### Example 3 (Merritt)

"Symmetrical crowning is applied in order to avoid hard bearing at tooth-ends, which might otherwise occur as a result of errors of tooth alignment," says Merritt. According to Merrit, crowning can be based on the gear's pitch, with crowning per flank commonly around .005/P to .01/P.

Assuming a square pinion, the pitch diameter would be 2.000 inches.

Pitch 10 NDP (2.54 module), 20 teeth
Crown Minimum = 0.005/NDP = 0.0005" (0.0127 mm)
Maximum = 0.01/NDP = 0.0010" (0.0254 mm)

Pitch 20 NDP (1.27 module), 40 teeth
Crown Minimum = 0.005/NDP = 0.0003" (0.0064mm)
Maximum = 0.01/NDP = 0.0005" (0.0127 mm)

### Example 4 (Dudley)

"In effect, crowning allows a rocking-chair-like action between the teeth when the shafts deflect into increasingly nonparallel positions," Dudley says. "Heavy concentrations of load at the ends of the teeth are avoided." Dudley suggests that the ends of crowned gears are made .0005 to .0020" thinner at the ends as compared to the middle.

Crown Minimum = 0.00025" (0.0635 mm)
Maximum = 0.0010" (0.0254 mm)

### Example 5 (National Broach)

According to this handbook, "Excessive crowning is as great an evil as no crowning. When the amount of crown is too great, effective face width is sacrificed...If the accumulated mounting errors or shaft deflection appear to call for gear tooth crowning in excess of 0.0005-in. per inch of face width on each tooth side, more rigid mounts, or stronger gear teeth should be considered."

Face 2.000" (50.8 mm)
Crown Maximum = Face • 0.0005 = 0.0010" (0.0254 mm)

### Discussion

I prefer the methods that have the amount of crown as a function of the face width. This eliminates References 3 and 4.

The method given in Reference 2 seems to give too small an amount of crown.

The Reference 1 method is similar to the method given in Reference 5, but has a tolerance range. There should be a tolerance on the amount of crown, so I like the method given in Reference 1 best. This reference actually mentions Reference 5.


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***Power Transmission Engineering*** **"Expert"/Technical Editor Octave LaBath with his gear apprentice Max, who also happens to be his grandson.**