SECTION 4. Gear Strength Calculations

4.00 **In Fine-Pitch Gearing Applications,** gear trains are sometimes subject to high static loads. An example would be when a mechanism is driven into a mechanical stop. It is extremely important that the gears be capable of withstanding this maximum static torque.

The following section contains a method by which static strength of gears can be calculated, in addition to a graphical representation of the strengths of different sizes of gears.

4.01 **The Lewis Formula** is used for determining the force which may safely be applied to spur gear teeth. This formula considers the gear as a cantilever beam with the full load applied to one tooth. It should be remembered that more than one tooth is actually in contact during engagement and therefore the load is partially shared with another pair of teeth. The amount of this load distribution is dependent upon the contact ratio of the particular gears in mesh. Typical values are from 1.2 to 1.8.

4.02 **The Curves** (Figure 4.1) are based on the Lewis Formula (using 303 Stainless Steel, S = 30,000 psi)

$$L = \frac{SFY}{P} \text{ where}$$

L = Maximum safe tangential load at pitch diameter, lbs.

*S_s = Allowable static unit stress for material, psi

S = Allowable unit stress for material at given velocity

$$\left(S = S_s \times \frac{600}{600 + V}\right), \text{ psi}$$

V = Velocity, FPM at pitch diameter

F = Face width of gear, in.

Y = Outline factor (machinery handbook, 16th ed. p717)

P = Diametral pitch

* The curves represent static gear tooth strength, therefore

$$V = 0 \text{ and } S = S_s$$

Method 1. Using Lewis Formula

Static torque capacity, $T_s = \frac{L \times P.D.}{2}$ in. oz.

$P.D. = \frac{\text{No. Teeth}}{\text{Pitch}} = \frac{50}{48} = 1.0417$ in.

S = 40,000 psi (See Table 4.1)

F = .187 in.

Y = .408

P = 48

$L = \frac{SFY}{P} = \frac{(40{,}000)\ (.187)\ (.408)\ (16)}{48}$

L = 1017.28 ounces

$T_s = \frac{1017.28 \times 1.0417}{2} = 529.85$ In. Oz.

Method 2. Using Torque Curves

Start at 50 Teeth on on Graph

Go to 48 Pitch Curve

Read Torque 132 in. oz. for 1/16 Face Width

Multiply by 3 for 3/16 Face Width = 396 in. oz.

Since the curves are based on 303 Stainless Steel with a yield strength of 30,000 psi, torque must be multiplied by strength factor 1.33 to determine capacity of 2024-T4 Aluminum Gear (40,000 psi).

$T_s = 396 \times 1.33 = 528$ in. oz.

EXAMPLE: Determine the Static Torque capacity (T_s) of a 48 Pitch, 50 Tooth, 2024-T4 Aluminum Gear. Face width 3/16 inch.

TABLE 4.1
YIELD STRENGTH FOR VARIOUS MATERIALS

Material	Yield Strength, PSI*	Strength Factor
416 Stainless Steel (Annealed)	40,000	1.33
416 Stainless Steel (RC22)	95,000	3.16
416 Stainless Steel (RC37)	134,000	4.46
303 Stainless Steel	30,000	1.00
17-4PH Stainless Steel (Cond. H900)	170,000	5.66
2024-T4 Aluminum Alloy	40,000	1.33
Bronze	20,000	.66
Phenolic	8,000	.27
Nylon, Delrin	6,000	.20

* Data approximate, subject to variations among suppliers.

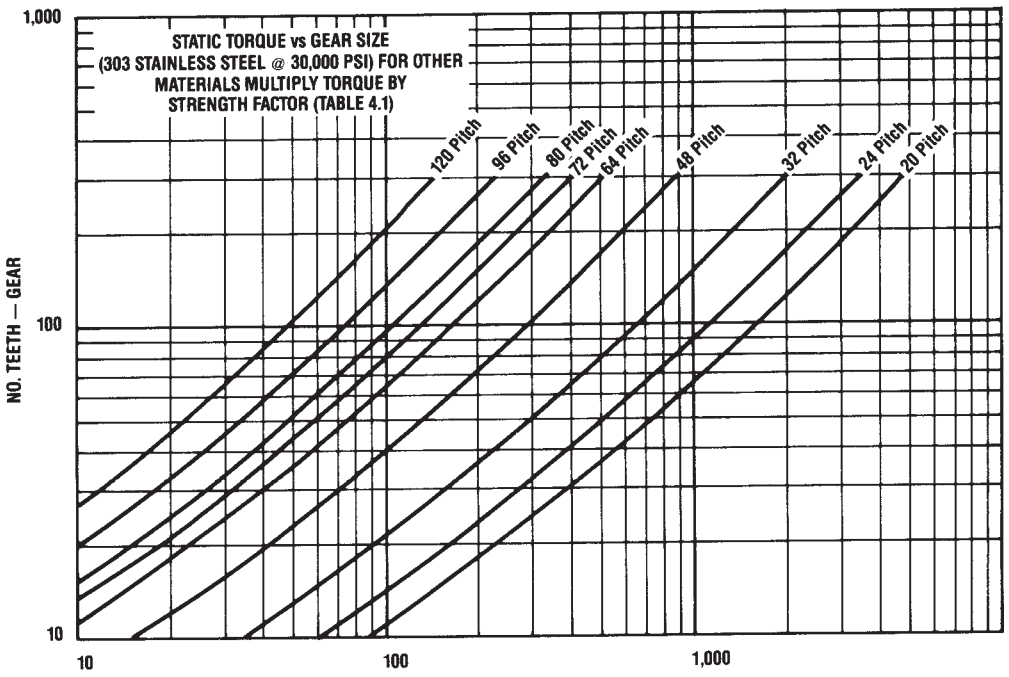

FIGURE 4.1 — STATIC TORQUE IN. OZ. (PER 1/16" FACE WIDTH GEAR)

Phone: 800-243-6125 ▪ FAX: 203-758-8271
E-Mail: sales@pic-design.com