9.3.3.3 Bevel Gears *using Mott

Let's get right to it:

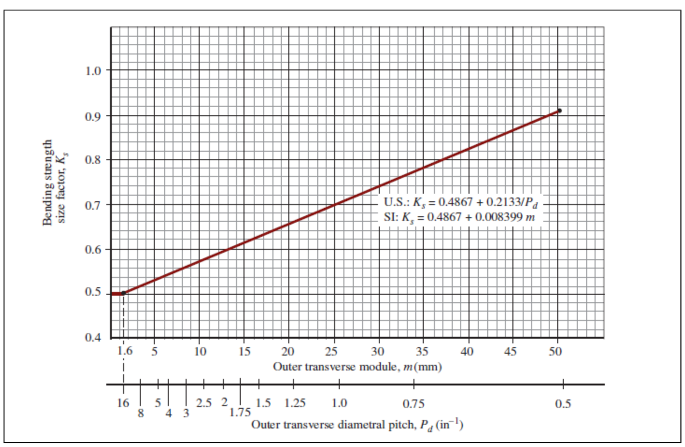
1. **Find the type of shock and K_o from the spur gear guide**
2. **Calculate any missing values such as N or F using the spur gear guide**
3. **Find the load transmitted, and the pitch line velocity**

$$\nu_t = \frac{\pi D n}{12}$$

$$W_t = \frac{33000P}{\nu_t}$$

4. **Find the size factor, K_s, using the equations below or the table:**

$$K_s = \begin{cases} 0.5 & P_d \geq 16 \\ 0.4867 + \frac{0.2133}{P_d} & P_d < 16 \end{cases}$$



5. **Find $K_m b$ where:**

   $K_{mb} = 1$ for both gears straddle mounted
   $K_{mb} = 1.1$ for one gears straddle mounted
   $K_{mb} = 1.25$ for neither gears straddle mounted

6. **Find K_m using $K_m b$ and F:**

$$K_m = K_{mb} + 0.0036F^2$$

7. **If the quality number, Av, is given use that. If not, use this table:**

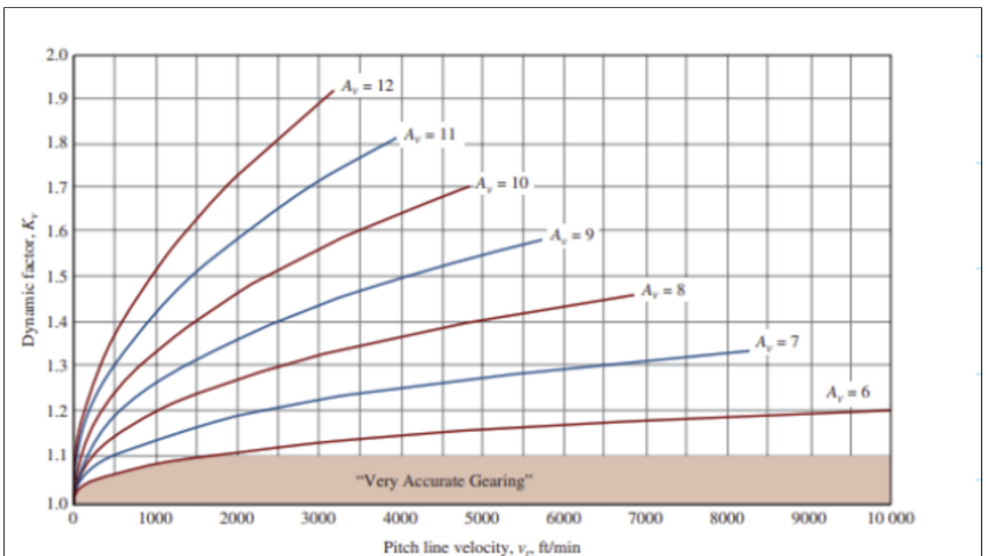
TABLE 9–5 Recommended AGMA Quality Numbers

Application	Quality number	Application	Quality number
Cement mixer drum drive	A11	Small power drill	A9
Cement kiln	A11	Clothes washing machine	A8
Steel mill drives	A11	Printing press	A7
Grain harvester	A10	Computing mechanism	A6
Cranes	A10	Automotive transmission	A6
Punch press	A10	Radar antenna drive	A5
Mining conveyor	A10	Marine propulsion drive	A5
Paper-box-making machine	A9	Aircraft engine drive	A4
Gas meter mechanism	A9	Gyroscope	A2

Machine tool drives and drives for other high-quality mechanical systems

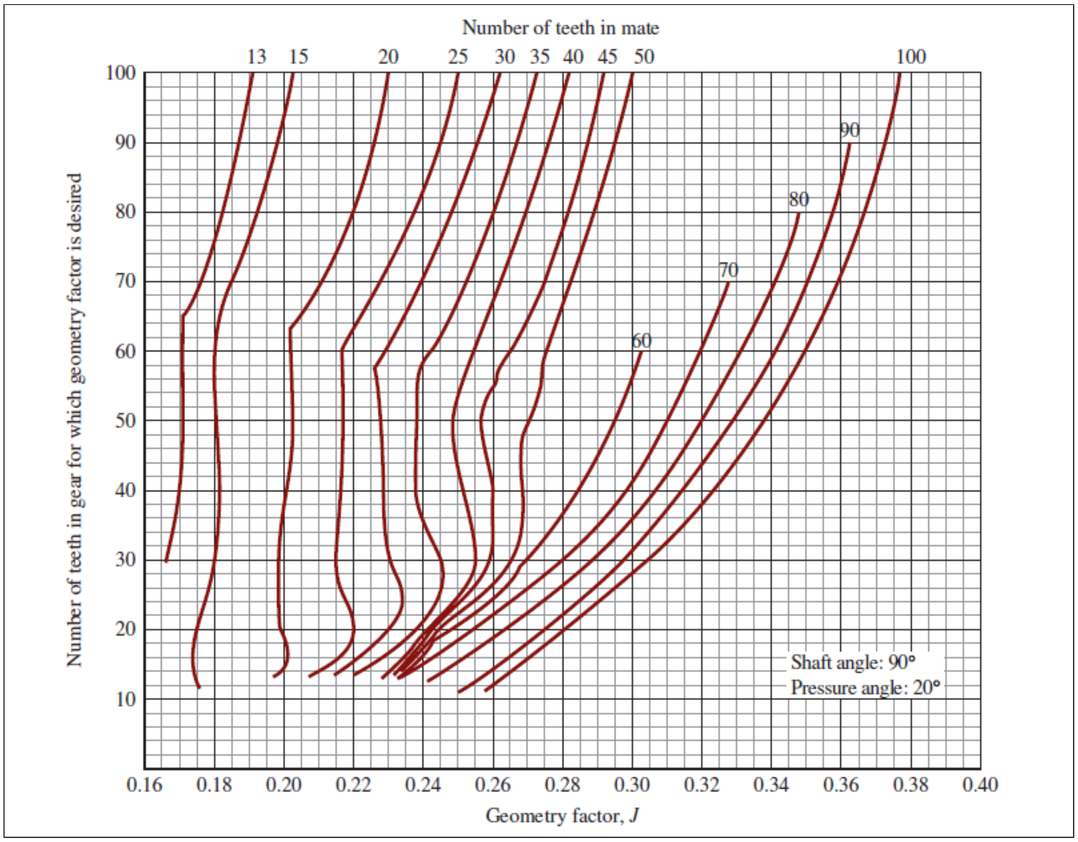
Pitch line speed (fpm)	Quality number	Pitch line speed (m/s)
0–800	A10	0–4
800–2000	A8	4–11
2000–4000	A6	11–22
Over 4000	A4	Over 22

8. **Find K_v from the graphs below:**



(a) U.S. Customary units

9. **Find J using the graph shown below:**



10. **Calculate the bending stress number:**

$$s_t = \frac{W_t P_d K_O K_s K_m K_v}{FJ}$$

11. **Choose a safety factor of 1 for now:**

12. **Assume** 99% **reliability and thus choose** K_R **as 1, make a note of what** C_R **is, also going to typically be 1 just like every other one of these stupid ass factors, anyway if you have a reason for higher or lower reliability use the table below:**

TABLE 10-3 Reliability Factors for Allowable Bending and Contact Stresses

Reliability R	Interpretation	Reliability factors: Bending K_R	Reliability factors: Contact C_R
0.9	Fewer than one failure in 10	0.85	0.92
0.99	Fewer than one failure in 100	1.00	1.00
0.999	Fewer than one failure in 1000	1.25	1.12
0.9999	Fewer than one failure in 10 000	1.50	1.22

Source: Adapted from AGMA 2003-C10, *Rating the Pitting Resistance and Bending Strength of Generated Straight Bevel, Zerol Bevel and Spiral Bevel Gear Teeth*, with the permission of the publisher, American Gear Manufacturers Association, 1001 North Fairfax Street, 5th Floor, Alexandria, VA.

13. **Using the lifetime of the machine, calculate the number of load cycles, N_L**

$$N_{LP} = (60)(lifetime)n_P$$

$$N_{LG} = (60)(lifetime)n_G$$

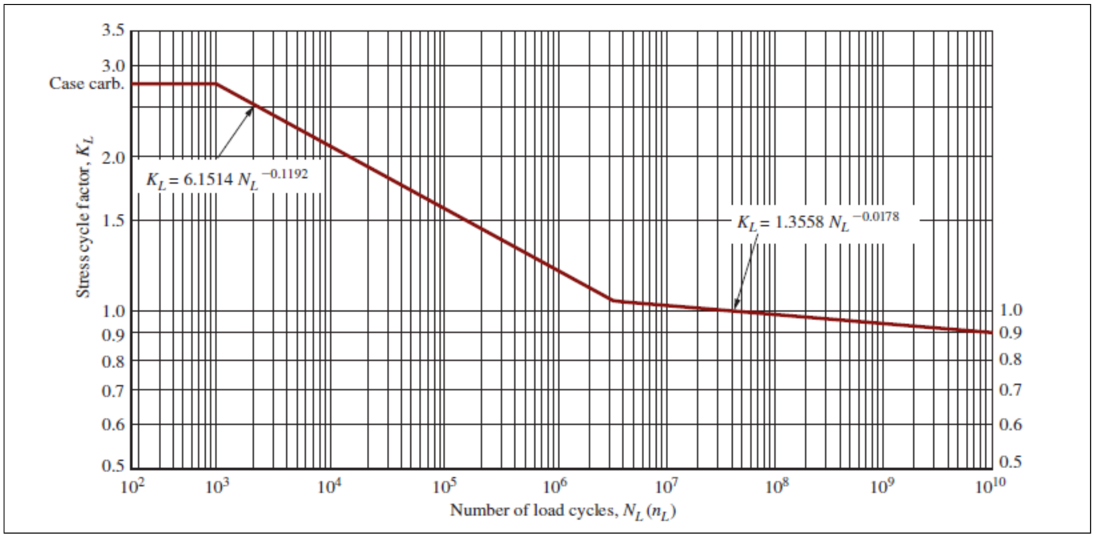
If lifetime is not specified then use this table:

TABLE 9-12 Recommended Design Life

Application	Design life (h)
Domestic appliances	1000–2000
Aircraft engines	1000–4000
Automotive	1500–5000
Agricultural equipment	3000–6000
Elevators, industrial fans, multipurpose gearing	8000–15 000
Electric motors, industrial blowers, general industrial machines	20 000–30 000
Pumps and compressors	40 000–60 000
Critical equipment in continuous 24-h operation	100 000–200 000

Source: Eugene A. Avallone and Theodore Baumeister III, eds. *Marks' Standard Handbook for Mechanical Engineers*. 9th ed. New York: McGraw-Hill, 1986.

14. **Find the stress cycle factor, K_L, from the graph below:**



15. **Find the allowable bending stress:**

$$s_{at} = \frac{s_t(SF)K_R}{K_L}$$

16. **Perform a similar analysis to spur gears for specifying a material and calculating a safety factor**

17. **To find the critical stress, choose $C_p = 2300$ for steel**

18. **Calculate the pitting resistance size factor, Cs, using this formula/table:**

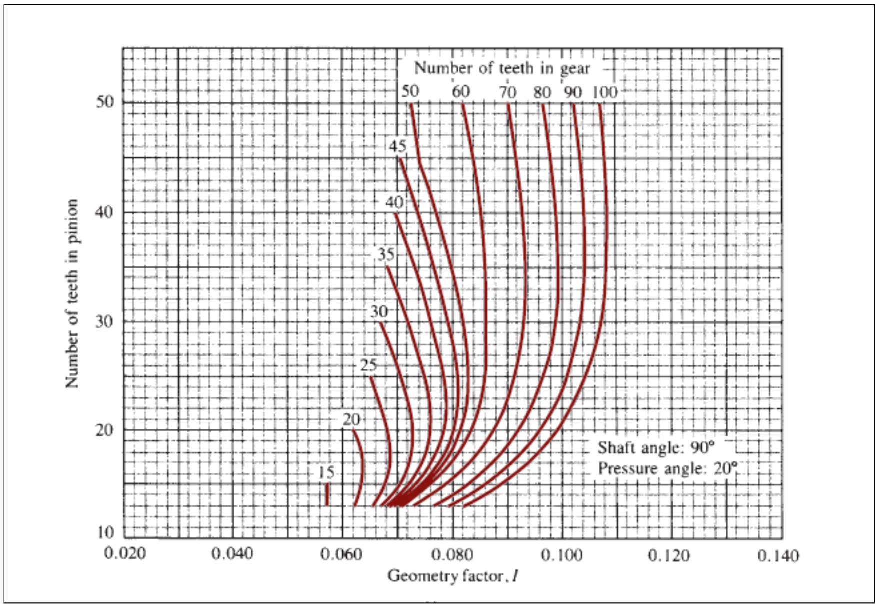
$$C_s = 0.125F + 0.4375$$

19. **Calculate the crown factor, C_{xc}, to be one of the following:**

    $C_{xc} = 1.5$ for properly crowned teeth (this is the assumption we use)

    $C_{xc} = 2$ for non-crowned teeth

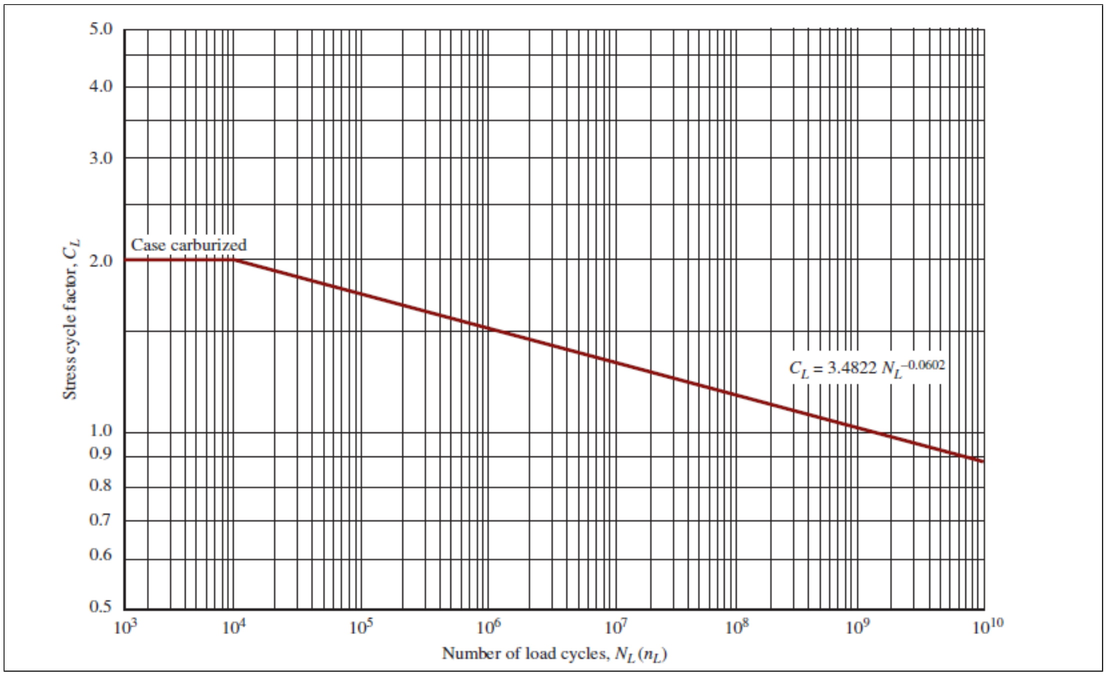
20. **Calculate I from the graph below:**



21. **Calculate the contact stress number:**

$$s_c = C_p \sqrt{\frac{W_t K_O K_m K_\nu C_a C_{xc}}{F D_p I}}$$

22. **Calculate the stress cycle factor, C_L, from the graph below:**



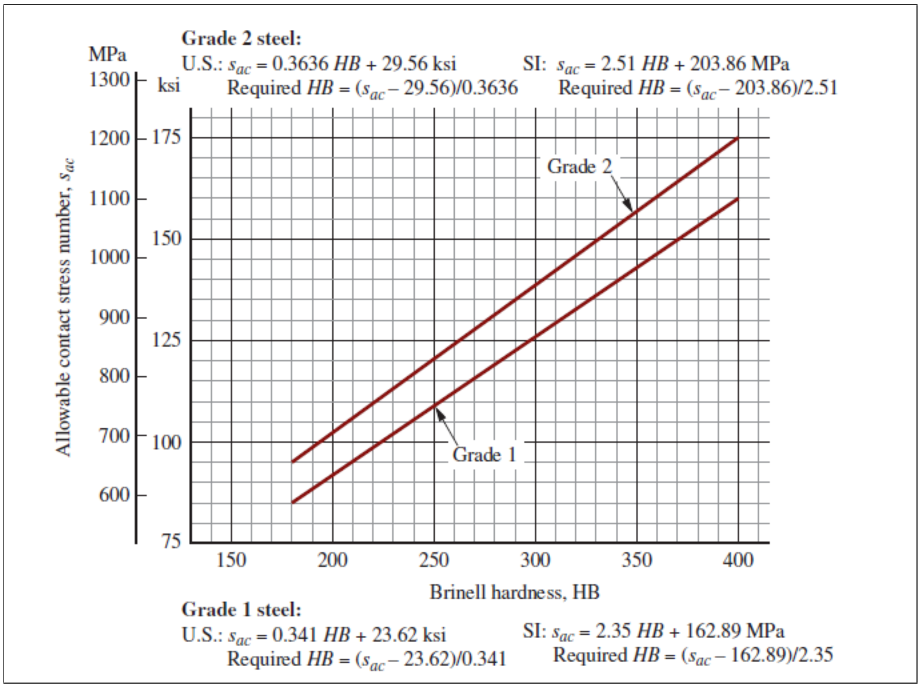
23. **Calculate the allowable contact stress number using the following formula:**

$$s_a c = \frac{s_c(SF)C_R}{C_L}$$

24. **Perform a similar analysis to spur gears for finding the material and associated safety factor**. However you will use these graphs below and a different formula for the safety factor which is:

$$SF = \frac{s_{ac}C_L}{s_c C_R}$$

$$SF = \frac{s_{at}K_L}{s_t K_R}$$

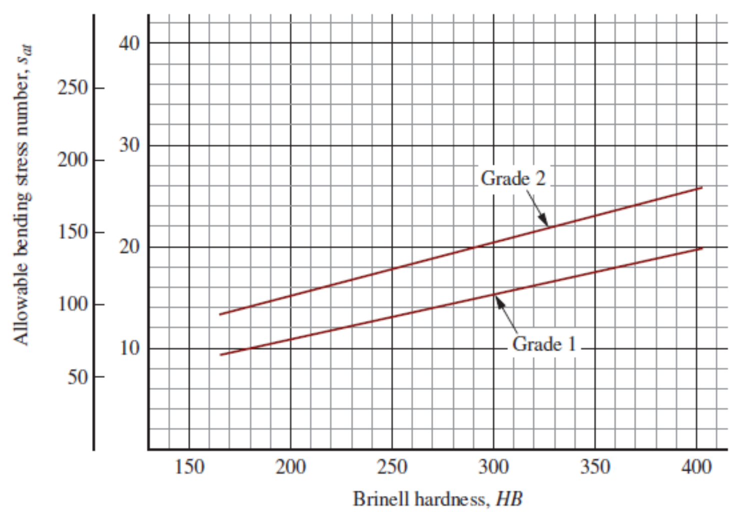


Note that these graphs are different from the ones used in the spur gears they have different numbers so be sure to use the ones here.

Grade 2 steel:

U.S.: $s_{at} = 0.048\,HB + 5.980$ ksi SI: $s_{at} = 0.33\,HB + 41.24$ MPa

Required $HB = (s_{at} - 5.980)/0.048$ Required $HB = (s_{at} - 41.24)/0.33$



Grade 1 steel:

U.S.: $s_{at} = 0.044\,HB + 2.10$ ksi SI: $s_{at} = 0.30\,HB + 14.48$ MPa

Required $HB = (s_{at} - 2.10)/0.044$ Required $HB = (s_{at} - 14.48)/0.30$