

11.4 Axial (Overlap) Contact Ratio, ϵ_b

Helical gears and spiral bevel gears have an overlap of tooth action in the axial direction. This overlap adds to the contact ratio. This is in contrast to spur gears which have no tooth action in the axial direction. Thus, for the same tooth proportions in the plane of rotation, helical and spiral bevel gears offer a significant increase in contact ratio. The magnitude of axial contact ratio is a direct function of the gear width, as illustrated in **Figure 11-3**. Equations for calculating axial contact ratio are presented in **Table 11-4**.

It is obvious that contact ratio can be increased by either increasing the gear width or increasing the helix angle.

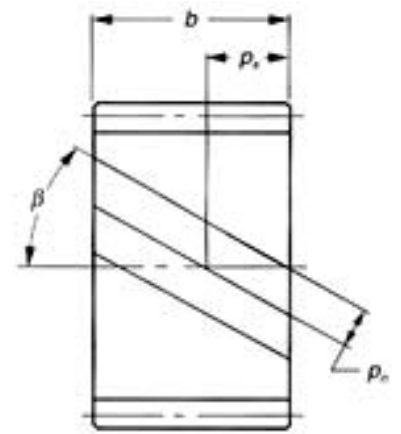


Fig. 11-3 Axial (Overlap) Contact Ratio

Table 11-2 Equations for Contact Ratio for a Bevel Gear Pair

Item	Symbol	Equation for Contact Ratio	
Back Cone Distance	R_v	$\frac{d}{2\cos\delta}$	
Base Circle Radius of an Equivalent Spur Gear	R_{vb}	Straight Bevel Gear $R_v \cos\alpha$	Spiral Bevel Gear $R_v \cos\alpha_t$
Outside Radius of an Equivalent Spur Gear	R_{va}	$R_v + h_a$	
Contact Ratio	ϵ_a	Straight Bevel Gear $\frac{\sqrt{R_{va1}^2 - R_{vb1}^2} + \sqrt{R_{va2}^2 - R_{vb2}^2} - (R_{v1} + R_{v2})\sin\alpha}{\pi m \cos\alpha}$	
		Spiral Bevel Gear $\frac{\sqrt{R_{va1}^2 - R_{vb1}^2} + \sqrt{R_{va2}^2 - R_{vb2}^2} - (R_{v1} + R_{v2})\sin\alpha_t}{\pi m \cos\alpha_t}$	

Table 11-3 Equations for Contact Ratio of Nonparallel and Nonintersecting Meshes

Type of Gear Mesh	Equation of Contact Ratio, ϵ
Screw Gear ① Screw Gear ②	$\frac{\sqrt{\left(\frac{d_{a1}}{2}\right)^2 - \left(\frac{d_{b1}}{2}\right)^2} + \sqrt{\left(\frac{d_{a2}}{2}\right)^2 - \left(\frac{d_{b2}}{2}\right)^2} - a - \frac{d_{b1}\cos\alpha_{t1}}{2} - \frac{d_{b2}\cos\alpha_{t2}}{2}}{\pi m_n \cos\alpha_n}$
Worm ① Worm Gear ②	$\frac{h_{a1} - x_{s2}m_x + \sqrt{\left(\frac{d_{m1}}{2}\right)^2 - \left(\frac{d_{b2}}{2}\right)^2} - \frac{d_z}{2}\sin\alpha_x}{\pi m_x \cos\alpha_x}$

Table 11-4 Equations for Axial Contact Ratio of Helical and Spiral Bevel Gears, ϵ_β

Type of Gear	Equation of Contact Ratio	Example
Helical Gear	$\frac{b \sin\beta}{\pi m_n}$	$b = 50, \beta = 30^\circ, m_n = 3$ $\epsilon_\beta = 2.6525$
Spiral Bevel Gear	$\frac{R_s}{R_s - 0.5b} \frac{b \tan\beta_m}{\pi m}$	From Table 8-6 : $R_s = 67.08204, b = 20,$ $\beta_m = 35^\circ, m = 3, \epsilon_\beta = 1.7462$

NOTE: The module m in spiral bevel gear equation is the normal module.

SECTION 12 GEAR TOOTH MODIFICATIONS

Intentional deviations from the involute tooth profile are used to avoid excessive tooth load deflection interference and thereby enhances load capacity. Also, the elimination of tip interference reduces meshing noise. Other modifications can accommodate assembly misalignment and thus preserve load capacity.

12.1 Tooth Tip Relief

There are two types of tooth tip relief. One modifies the addendum, and the other the dedendum. See **Figure 12-1**. Addendum relief is much more popular than dedendum modification.

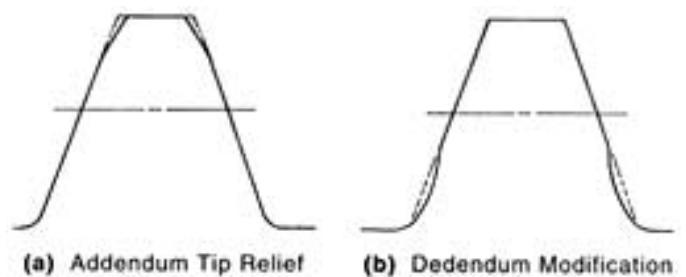


Fig. 12-1 Tip Relief