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.

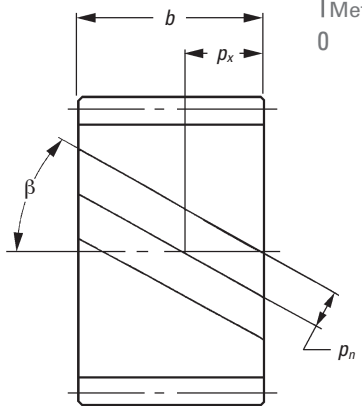


Fig. 11-3 Axial (Overlap) Contact Ratio

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

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

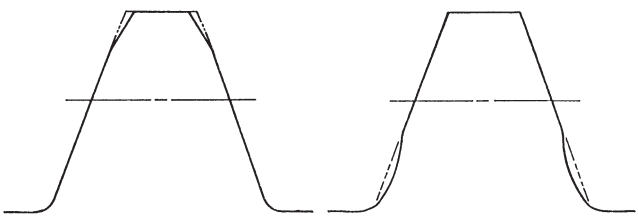
NOTE: The module *m* in spiral bevel gear equation is the normal module.

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.



(a) Addendum Tip Relief **(b)** Dedendum Modification

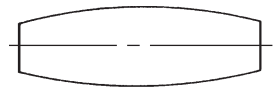
Fig. 12-1 Tip Relief

12.2 Crowning And Side Relieving

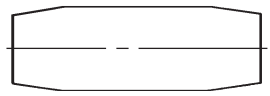
Crowning and side relieving are tooth surface modifications in the axial direction. See **Figure 12-2**.

Crowning is the removal of a slight amount of tooth from the center on out to reach edge, making the tooth surface slightly convex. This method allows the gear to maintain contact in the central region of the tooth and permits avoidance of edge contact with consequent lower load capacity. Crowning also allows a greater tolerance in the misalignment of gears in their assembly, maintaining central contact.

Relieving is a chamfering of the tooth surface. It is similar to crowning except that it is a simpler process and only an approximation to crowning. It is not as effective as crowning.



(a) Crowning



(b) Side Relieving

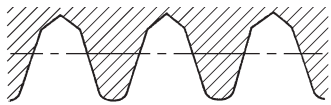
Fig. 12-2 Crowning and Relieving

12.3 Topping And Semitopping

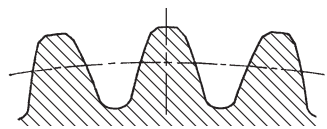
In topping, often referred to as top hobbing, the top or outside diameter of the gear is cut simultaneously with the generation of the teeth. An advantage is that there will be no burrs on the tooth top. Also, the outside diameter is highly concentric with the pitch circle. This permits secondary machining operations using this diameter for nesting.

Semitopping is the chamfering of the tooth's top corner, which is accomplished simultaneously with tooth generation. **Figure 12-3** shows a semitopping cutter and the resultant generated semitopped gear. Such a tooth tends to prevent corner damage. Also, it has no burr. The magnitude of semitopping should not go beyond a proper limit as otherwise it would significantly shorten the addendum and contact ratio. **Figure 12-4** specifies a recommended magnitude of semitopping.

Both modifications require special generating tools. They are independent modifications but, if desired, can be applied simultaneously.



(a) Teeth Form of Semitopping Cutter



(b) Semitopped Teeth Form

Fig. 12-3 Semitopping Cutter and the Gear Profile Generated

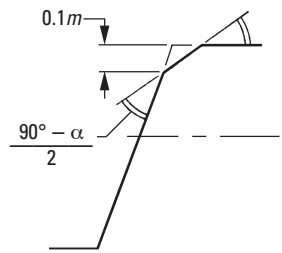


Fig. 12-4 Recommended Magnitude of Semitopping