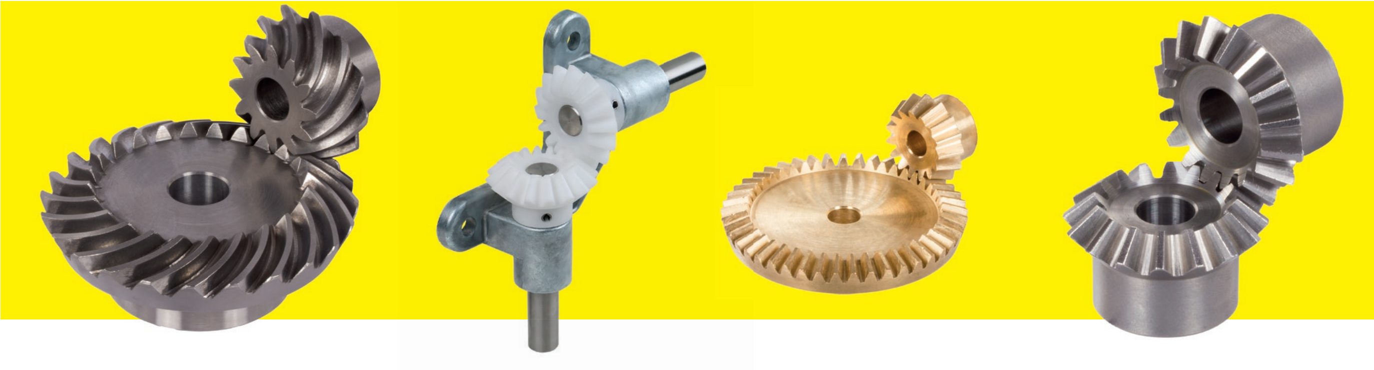
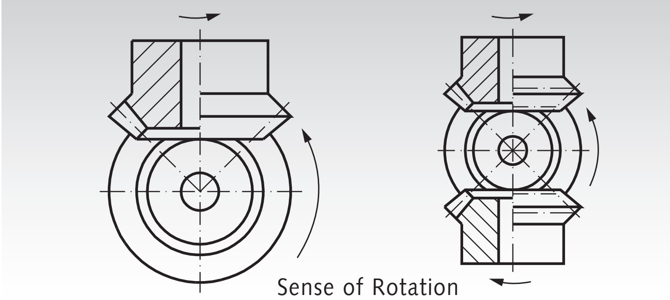
Bevel Gears Overview



Contents

General Basics about Bevel Gears

Bevel gears enable a non-slip power transmission between two shafts mounted at 90 degrees.
Available from stock are transmission ratios of 1:1 up to max. 1:5 (depending on the material used). Other than for spur gears, the module is not standardized, but is chosen with view to technical considerations. The module of the bevel gear is not a constant value, but it changes with the diameter.



Bevel Gears with Straight-Tooth System

to be calculated	given unit	formula
Module $= m$	Pitch p Pitch Ø and No. of Teeth	$\frac{p}{\pi}$ $\frac{d}{z}$
Pitch Ø $= d$	No. of Teeth and Module	$z \cdot m$
Pitch (Cone) Angle Gear 1 $= \delta_{01}$	No. of Teeth Gear 1 and Gear 2	$\frac{z\,1}{z\,2} = \tan\ \delta\ 01$
Pitch (Cone) Angle Gear 2 $= \delta_{02}$	Angle of Axles and Pitch (Cone) Angle, Gear 1	$\delta a - \delta\ 01$
Addendum Angle $= \chi_k$	Pitch (Cone) Angle and No. of Teeth Module and Outer Cone Distance R_a	$\frac{2 \cdot \sin\ \delta 0}{z} = \tan \chi_k$ $\frac{m}{R_a} = \tan \chi_k$
Tip Ø $= d_a$	Pitch Ø, Pitch (Cone) Angle and Module No. of Teeth, Pitch (Cone) Angle and Module	$d + (2m \cdot \cos\ \delta 0)$ $z \cdot m + (2m \cdot \cos\ \delta 0)$
Tip (Cone) Angle $= \delta_k$	Pitch (Cone) Angle and Addendum Angle	$\delta 0 + \chi_k$
Outer Cone Distance Cone Distance $= R_a$	Pitch (Cone) Diameter Ø and Pitch (Cone) Angle	$\frac{d}{2 \cdot \sin\ \delta 0}$
Gear 1 = big gear, Gear 2 = small gear		
Torque = Md in Nm	Power and Speed	Gear 1: $9550\ \frac{P}{n_1}$ Gear 2: $9550\ \frac{P}{n_2}$

Tooth Width maximum 0.4 x Outer Cone Distance R_a .
For Bevel Gears with a Shaft Angle larger or smaller than 90°, the following formula applies for the calculation of the Pitch (Cone) Angle

$$\frac{z\ 2}{Z_1 \cdot \sin\ \delta_a} + \cot\ \delta a = \cot\ \delta 01$$

Note: if δ_{01} is given, then $\delta_{k2} = \delta_a - (\delta_{01} - \chi_k)$
Addendum Angle is the same for both gears: $\chi_k = \chi_{k1} = \chi_{k2}$
Tangent = tan, Cotangent = cot

Material quality: information about the material quality can be found at each individual group of bevel gears.

Recommendations for the Lubrication of Bevel-Gear Sets

Peripheral speed	Lubrication	Lubricant
up to 1 m/s	Application of Lubricant	Adhesive Lubricant
up to 4 m/s	Splash Lubrication/Spray Lubrication	Grease or Adh. Lubricant
up to 15 m/s	Splash Lubrication	Oil
over 15 m/s	Pressure-Circulation or Spray Lubrication	Oil

Notes Regarding the Torque Values Stated

The load bearing capacity calculations for the bevel gears are based on the basic principles regarding the pitting resistance of the tooth flanks and the occurring tooth root stress. The calculations are based on the DIN 3991. For the calculation, the following assumptions were made:

If the transmission ratio is not 1 : 1 the stated max. torque applies to the smaller gear.

Calc. Factor/Determining Factor	Abbreviation	Value	Note
Calculation Method	-	-	DIN 3991
Normal Pressure Angle	-	20° (17.5° for spiral tooth system module 0.6 to 1.5)	
Spiral Angle	-	o° (38° for spiral tooth system)	
DIN Quality	-	8	-
Flank Safety	S_H	1.0 (apart from zinc)	Endurance strength 10.000 h (for steel)
Tooth-Root Safety	S_F	1.5	Endurance strength 10.000 h (for steel)
Application Factor	K_A	1.25	Industrial gear mechanisms, uniform, light shocks
Dynamics Factor	K_V	1.0	Usually without great influence
Load Distribution over Width	K_{Hbeta}	1.5 (1 for Polyacetal resin, Ms58 and ZnAl 4 Cu1)	Double-sided support
Lubricant/Surface Structure Speed Factor	$Z_L * Z_V * Z_R$	1	• sufficient oil lubrication • relative surface roughness R_{Z100} = 10 • peripheral speed 8 m/s
Lifetime Factor	Z_N	1	Endurance strength 10.000 h (for steel)
Operating temperature for plastic gears	T_{Betr}	up to 60°C	The material parameters of plastic gears highly depend on the temperature

The load bearing capacity of a bevel gear depends on various different factors. The torques stated are only reference values serving to facilitate the selection process. If necessary a specific calculation of strength and load bearing capacity must be carried out for each application.

Depending on the operating conditions the wear lifespan may be influenced by adequate grease/oil lubrication. Please also note that insufficient lubrication may lead to scuffing of the gear flanks.

IMPORTANT

Please make sure you always check the permissible torque separately for the pinion and the gear side!
Plastic gears are, due to the higher elasticity, calculated with a K_{Hbeta} of 1. Gears made from brass and zinc-die-cast are also calculated with a K_{Hbeta} of 1, as a good running-in characteristic is assumed for these materials.

In the torque calculation of zinc-die-cast bevel gears only the root strength was considered. Due to the material properties these gears are only to a limited extend suitable for continuous operation.

For the materials used, the following characteristic values were taken as basis:

Material	Perm. Pulsating Fatigue Strength under Bending Stress s_{bW} in N/mm²	Perm. Flank Pressure U_{Hlim} in N/mm²
Polyacetal resin	28 (VDI-2545)	40 (VDI-2545)
ZnAl4Cu1	60	150
Ms58 (2.0401)	100	250
11SMn30+SH (1.0715)	150	350
C45 normalized	200	590
42CrMo4 hardened	350	1360
16MnCr5 case hardened	400	1630
X10CrNiS18 9 (1.4305, stainless, austenitic)	200	400