TIMKEN

Gear Force Calculations Help Guide

Understanding Gear Forces

Gear forces are the forces exerted between meshing gears during operation. These forces are critical to the performance and reliability of bearing systems, as they influence the loads the bearings will carry in application. Understanding gear forces helps in designing bearing systems that can handle the required loads.

Gear forces can be categorized into three main types:

- Tangential Force (Ft): This is the force that drives the rotation of the gears. It acts along the tangent to the pitch circle of the gear and is responsible for transmitting power between the gears. The tangential force is calculated based on the torque applied to the gear and the radius of the pitch circle.
- Radial Force or Separating Force (Fs): This force acts perpendicular to the tangential force and along the radius of the pitch circle. It tends to push the gears apart and can cause deflection in the gear shafts. Radial force is a result of the pressure angle and the tangential force.
- Axial Force or Thrust Force (Fa): This force acts parallel to the axis of the gear shaft and is present in several gear types due to the angle of the gear teeth. Axial force can cause thrust loads on the bearings supporting the gear shafts.

The calculation of gear forces involves understanding both the gear geometry and the operating conditions.

The gear force calculation tool developed by Timken helps users determine the forces acting on gears in a system. By inputting the gear parameters and operating conditions, the tool calculates the tangential, radial and axial forces, providing valuable insights for bearing selection and analysis.

Understanding these forces is crucial for ensuring the reliability and performance of bearing systems. Properly designed bearing systems can handle the required loads and extend the service life of the system. Timken engineers can offer suggestions and support in optimizing bearing selections based on the calculated forces.

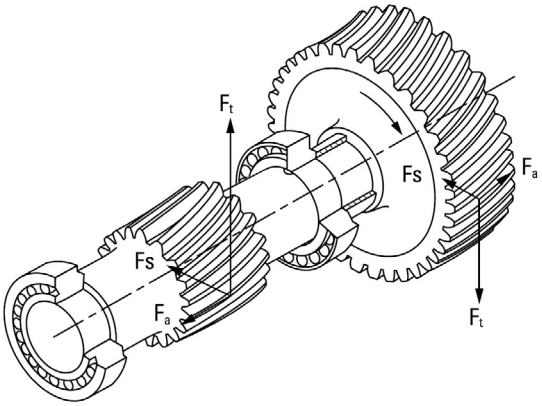

Fig. 1. Tangential, separating and axial forces labeled on two helical gears on a shaft.

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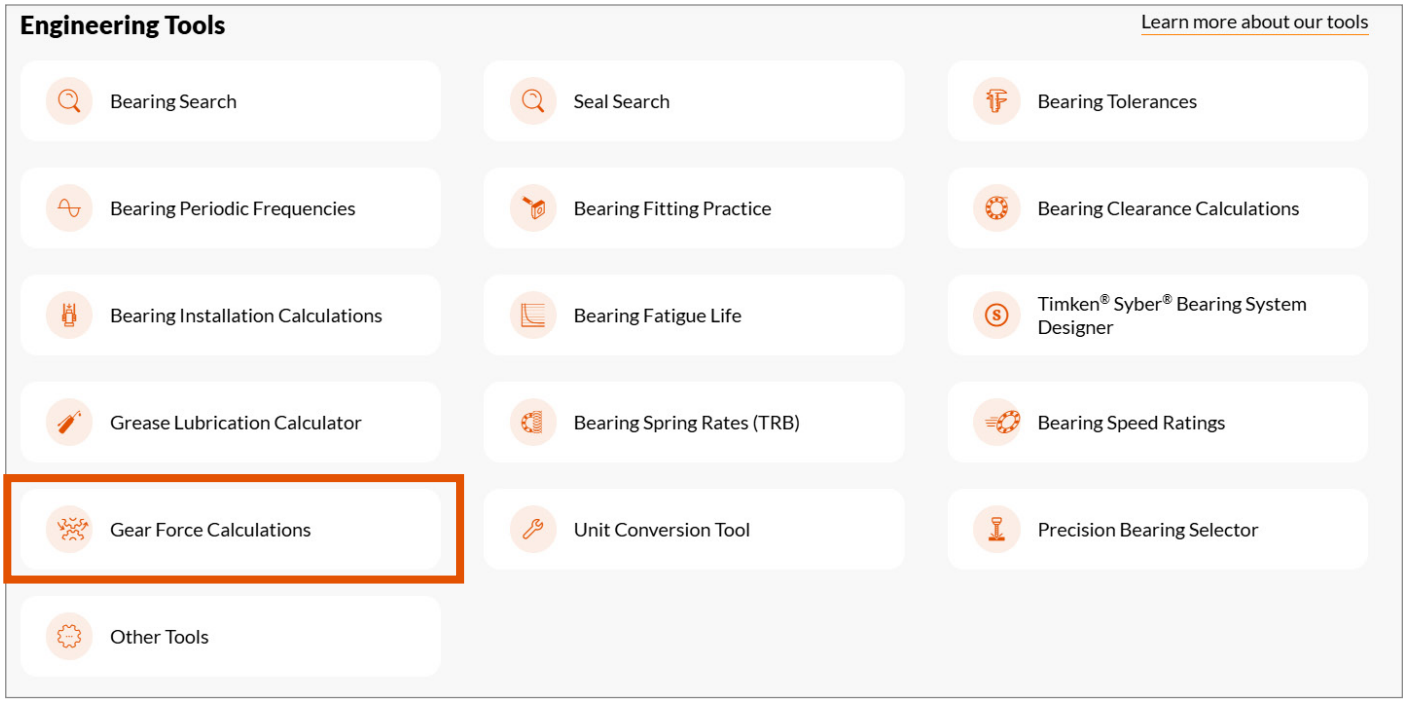
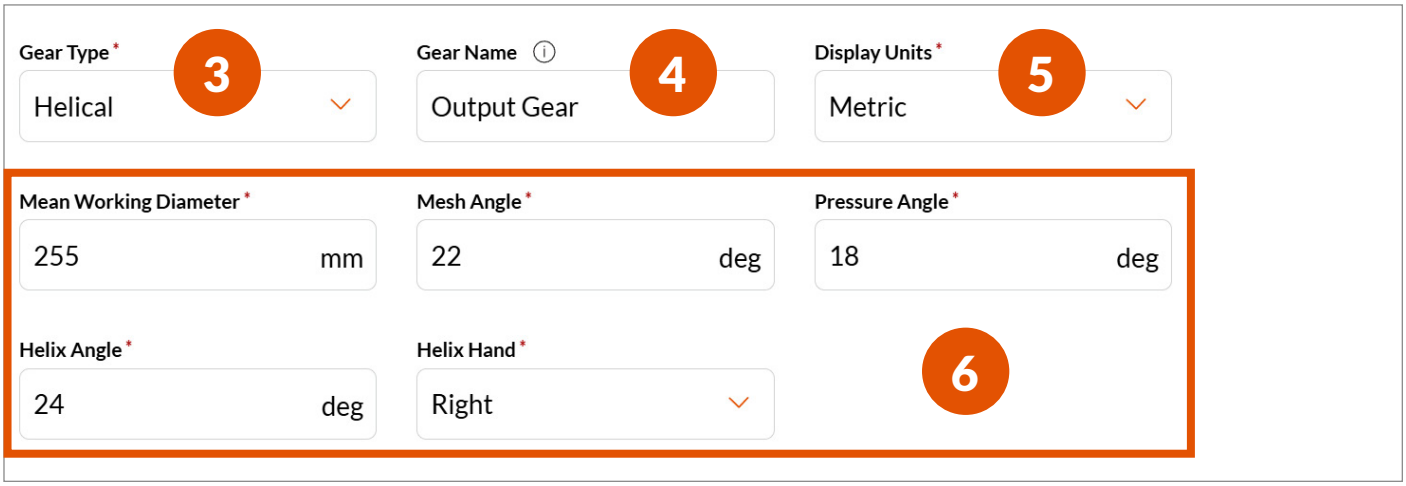
How to Use the Gear Force Calculation Tool

Follow these simple steps to get accurate gear force calculations to help you design Timken® bearings into your project.

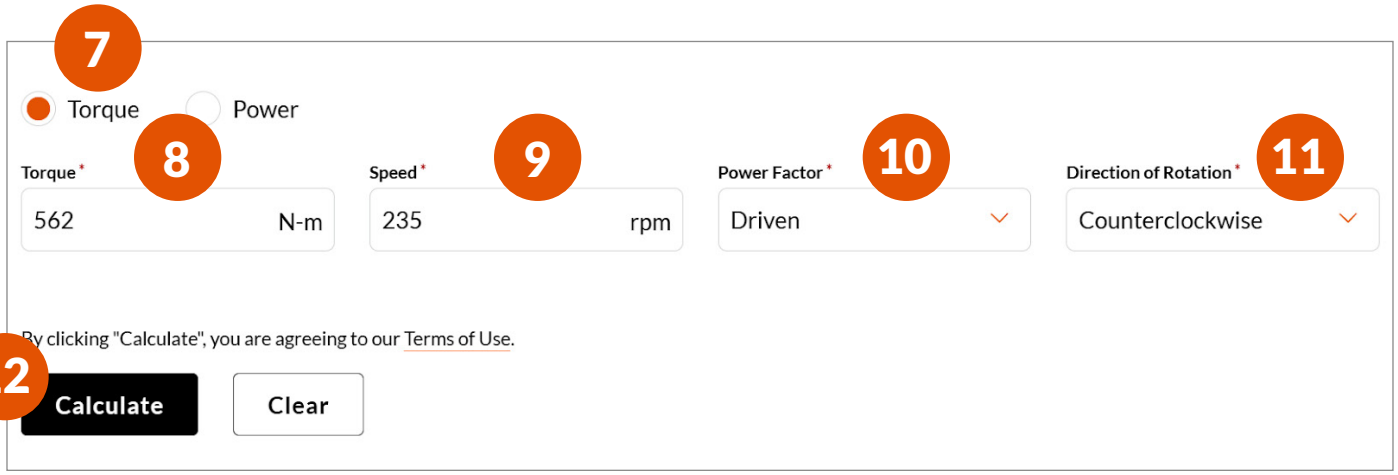
1. Go to engineering.timken.com.
2. Select Gear Force Calculations from the home page.

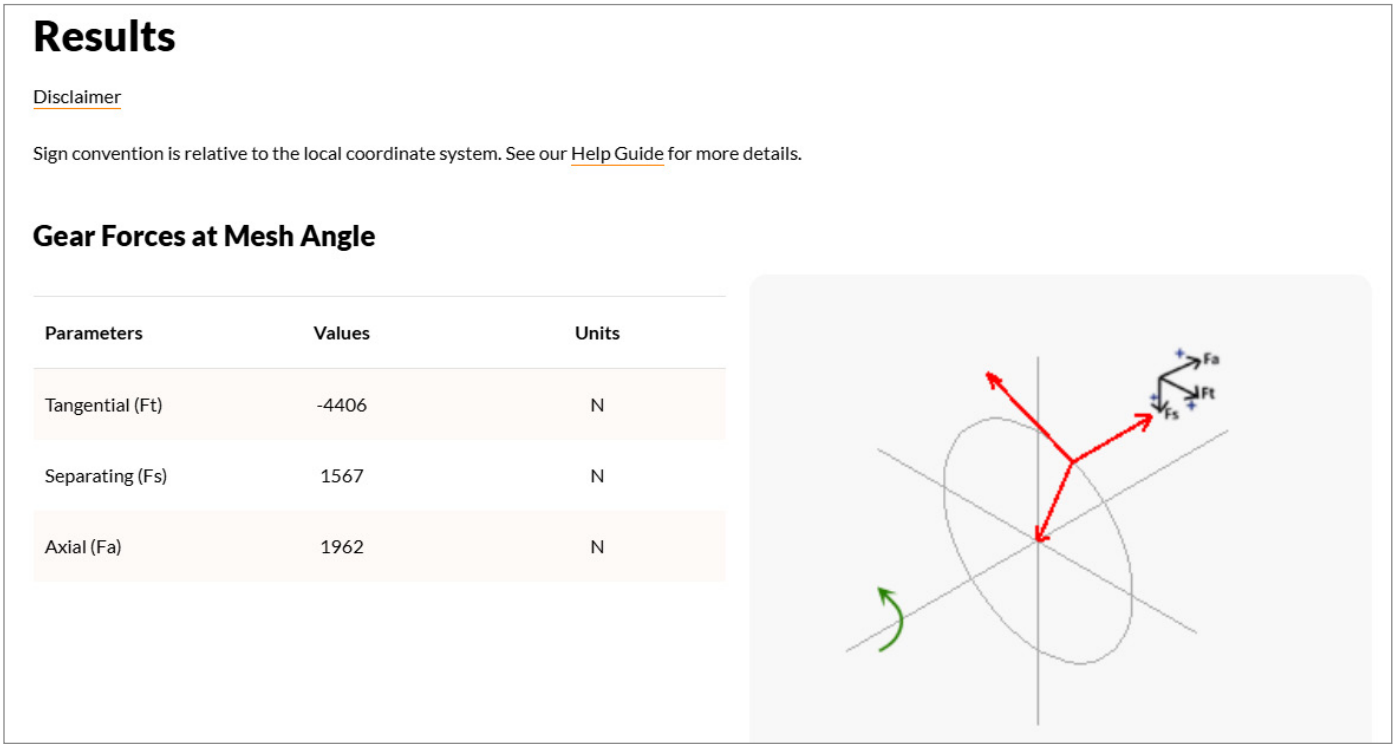


3. Select your Gear Type.
4. Enter a Gear Name (optional).
5. Select Display Units.
6. Enter the required gear parameters. Required gear parameters vary by Gear Type.



7. Select Torque or Power using the radio button depending on which loading data is available.
8. Enter the Torque or Power driving through the gear.
9. Enter the Speed of the gear.
10. Select a Power Factor, either Driven, if the gear is being driven by another gear, or Driving, if the gear is driving another gear.
11. Select the Direction of Rotation.
12. Select the Calculate button or hit Enter on your keyboard.





How to Apply the Results

You can take these results and ....

- Enter them into your design software.
- Enter them as external loads in Timken's Syber™ Bearing System Designer.
- Use the data to calculate bearing reaction forces (see the Timken Engineering Manual).

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Still Need Help?

- Contact your Timken sales office. Locate your local office by visiting locations.timken.com.
- Email us at TimkenEngineeringHelp@timken.com.

IMPORTANT NOTE: The accuracy of the technical information supplied through this engineering tool is dependent upon the accuracy and completeness of information supplied to Timken. Actual product performance is affected by many factors beyond the control of Timken, and which cannot be modeled through this engineering tool. Therefore, you must validate the suitability and feasibility of all designs and product selection. The technical information is presented solely to provide you, a customer of Timken or its affiliates, with data to assist you in your design. No warranty, expressed or implied, including any warranty of fitness for a particular purpose, is made by Timken through the provision of this information.

Appendix

Gear Force Sign Conventions

The Gear Force Calculation tool uses the sign convention shown to the right. Mesh angle is defined as the clockwise angle between the top dead center of the gear and the location of the gear mesh. The coordinate system will rotate with the mesh angle so that the tangential force (Ft) remains tangent to the pitch circle. The diagram generated in the results section will also show the direction of the forces and gear rotation.

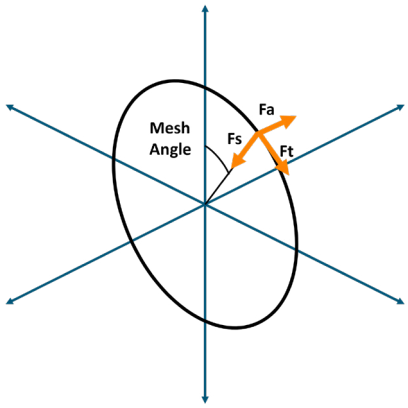

Fig. 2. Gear force sign conventions.

Gear Geometry Definitions

The following parameters are essential for calculating gear forces:

- **Center Distance:** The distance between the centers of the worm and the gear. It affects the meshing and loading of the worm gear.
- **Convex/Concave Pressure Angles:** The angles between the convex or concave surfaces of the hypoid gear teeth and the line of action. They affect the load distribution on the gears.
- **Gear Apex**: The location of the point where the gear teeth converge or the theoretical point where the gear teeth would meet if extended. The gear apex will either be on the right or left side of the gear. This parameter is used in bevel and hypoid gears to define the geometry.
- **Gearing Efficiency:** The ratio of the output power to the input power, expressed as a percentage. Gearing Efficiency is only used for worm gears and is influenced by the lead angle, material, and lubrication of the worm gear.
- **Helix Angle:** The angle between the helix of the gear teeth and the axis of the gear. It is used in helical and herringbone gears and affects the axial force and load distribution.
- **Helix Hand:** The direction of the helix angle, either left-hand (Left) or right-hand (Right). It determines the direction of the axial force generated by the gear.
- **Lead Angle:** The angle between the helix of the worm thread and the axis of the worm. It affects the efficiency and load capacity of the worm gear.
- **Mesh Angle:** The angle at which the gear teeth engage with each other. It influences the location of the loading and the loading on the bearings.
- **Pitch Angle:** The angle between the pitch line and the axis of the gear. It is used in bevel gears to define the gear geometry and the direction of force transmission.
- **Pressure Angle:** The angle between the line of action (the direction of the force transmission) and the tangent to the pitch circle. It affects the force distribution and the efficiency of power transmission.
- **Root/Face Angle:** The angle between the root or face of the gear tooth and the axis of the gear. This influences the loading on hypoid gears and pinions.
- **Spiral Angle:** The angle between the spiral of the gear teeth and the axis of the gear. It is used in spiral bevel and hypoid gears and affects the axial force.
- **Spiral Hand:** The direction of the spiral angle, either left-hand (Left) or right-hand (Right). It determines the direction of the axial force generated by the gear.

The Timken team applies their know-how to improve the reliability and performance of machinery in diverse markets worldwide. The company designs, makes and markets bearings, gear drives, automated lubrication systems, belts, brakes, clutches, chain, couplings, linear motion products and related industrial motion rebuild and repair services.