



# Ball Bearing Fundamentals

An Online Continuing Education Course for Engineers

**Course Number: M-3041**

**Credit: 3 Hours / 3 PDH / 3 CPD**

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## Introduction

One of the biggest challenges facing a ball bearing Application Engineer is to determine the forces (loads) that are acting on his product. The loads on ball bearings are either radial or thrust. The sketch at the top of Figure 1 shows that radial loads act perpendicular to the bearing axis of rotation and thrust loads act parallel to the axis of rotation. In some applications, there are two radial loads acting 90 degrees apart, as shown on the second sketch of Figure 1. The Pythagorean Theorem is then used to calculate the resultant radial load.

In most applications, there are two bearings supporting a rotating shaft on a piece of mechanical equipment. The third sketch on Figure 1 shows an applied load straddle mounted between two shaft supporting bearings. The radial loads on bearings I and II are calculated as follows:

$$L_I = \text{Load} \times b / ( a + b ) \quad L_{II} = \text{Load} \times a / ( a + b )$$

L is the radial load on bearings I and II. a and b are bearing locating dimensions shown on the third sketch of Figure 1. It can be seen that because the load is closer to bearing II, it supports the greater portion of the load. The fourth sketch on Figure 1 shows an overhung applied load acting on a shaft supported by two bearings. Overhung loads put a heavy force on the adjacent bearing. The following equations are used to calculate the radial load on bearings III and IV:

$$L_{III} = \text{Load} \times ( d / c ) \quad L_{IV} = \text{Load} \times ( c + d ) / c$$

It can be seen that the load on adjacent bearing IV is greater than the applied load itself. The loads acting on a bearing in pounds and its speed of rotation (rpm) are used to calculate bearing B10 life. Bearing B10 life predicts how many hours of operation 90% of the bearings will endure. The equation follows:

$$L_{B10} = 3000 ( C / P )^{10/3} \times ( 500 / S )$$

$L_{B10}$  is the bearing B10 life. C is the bearing capacity in pounds found in industry catalogs. P is the equivalent radial load in pounds which takes into account both radial and thrust loads also found in industry catalogs. S is the speed in revolutions per minute (rpm). Should a bearing operate under a number of different loads and speeds, the following equation is used to calculate B10 life:

$$L_{B10} = 1 / [ ( t_1 / L_1 ) + ( t_2 / L_2 ) + ( t_3 / L_3 ) + \text{etc} ]$$

$L_{B10}$  is the bearing B10 life in hours. t is the percent time spent at each different life (L) level. Bearing life calculations are necessary to determine if predicted values meet actual design requirements. The following table gives approximate bearing life levels for other survival rates should the application require something other than B10 life:

<u>% Survival</u>	<u>B - Life</u>	<u>% of B10 Life</u>
99	B-1	21
98	B-2	33
95	B-5	62
90	B-10	100
50	B-50	400
40	B-60	500

Following will be examples of how to calculate bearing loads for three commonly used gear drives for various mechanical devices using the information given above. The loads, and the speed equations which will also be given, can then be used to calculate the life of the bearing in the application.

**Figure 1**  
**Bearing Loads**

Thrust

To view the remainder of the course material and to take the quiz for PDH credit, you must purchase the course.

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