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Mounted Bearings Life Adjustment Factor

1.4 LIFE ADJUSTMENT FACTOR FOR APPLICATION CONDITIONS. Application conditions which affect bearing life include:

1. Lubrication.
2. Load distribution (including effects of clearance, misalignment, housing, and shaft stiffness, type of loading and thermal gradients).
3. Temperature.
   Consideration of (1.2) and (1.3) above requires analytical and experimental techniques beyond the scope of this discussion, therefore, the user should consult the bearing manufacturer for evaluations and recommendations.
   In most bearing applications, lubrication serves to separate the rolling surfaces; i.e., rolling elements and raceways; to reduce retainer-rolling elements and retainer-land friction and sometimes to act as a coolant to remove frictional heat generated by the bearing.
   If all limitations and qualifications specified by this discussion are observed, then the life adjustment application factor for bearings which are adequately lubricated is 1; i.e., a_3=1.
   Operating conditions where a_3 might be less than 1 include:
   a) Exceptionally low values of Ndm (rpm times bore diameter in mm); e.g., Ndm 1000.
   b) Lubricant viscosity less than 20.4 centistokes (100 SUS) at operating temperature.
   c) Excessively high operating temperatures.
   When a3 is less than 1, it may not be assumed that the deficiency in lubrication can be overcome by using an improved steel.

1.5 FACTOR COMBINATIONS. A fatigue life formula including the life adjustment factors is:

Ball Bearings:

$$L_n = a_1 \times a_2 \times a_3 \left(\frac{C^*}{P}\right)^3 \times \frac{(16.667)}{RPM}$$

Tapered Roller Bearings:

$$L_n = a_1 \times a_2 \times a_3 \left(\frac{C90^*}{P}\right)^{10/3} \times \frac{(1{,}500{,}000)}{RPM}$$

Spherical Roller Bearings:

$$L_n = a_1 \times a_2 \times a_3 \left(\frac{C^*}{P}\right)^{10/3} \times \frac{(16.667)}{RPM}$$

Indiscriminate application of the life adjustment factors in this formula may lead to serious over-estimation of bearing endurance, since fatigue life is only one criterion for bearing selection.

Care must be exercised to select bearings which are of sufficient size for the application. Undersizing of shaft and housing structures by using bearings which appear adequate from a life standpoint could lead to misalignment and fitting problems which could invalidate the formulas in this discussion.

* C = Basic Load Rating computed in accordance with ABMA-ANSI Standards. C90 = C x .259

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V-Belt Drive Formulas

V-belt tensioning In cases where tensioning of a drive effects belt pull and bearing loads, the following formulas may be used.

$$T_1 - T_2 = 33{,}000 \left(\frac{HP}{V}\right)$$

where: T_1 = tight side tension, pounds
T_2 = slack side tension, pounds
HP = design horsepower
V = belt speed, feet per minute

$$T_1 + T_2 = 33{,}000\ (2.5\text{-}G) \left(\frac{HP}{GV}\right)$$

where: T_1 = tight side tension, pounds
T_2 = slack side tension, pounds
HP = design horsepower
V = belt speed, feet per minute"
G = arc of contact correction factor*

$$T_1/T_2 = \frac{1}{1\text{-}0.8G} \quad (\text{Also } T1/T2 = e^{K\emptyset})$$

where: T_1 = tight side tension, pounds
T_2 = slack side tension, pounds
G = arc of contact correction factor*
e = base of natural logarithms
K = .51230, a constant for V-belt drive design
Ø = arc of contact in radians

$$T_1 = 41{,}250\ (HP/GV)$$

where: T_1 = tight side tension, pounds
HP = design horsepower
V = belt speed, feet per minute
G = arc of contact correction factor

$$T_2 = 33{,}000\ (1.25\text{-}G)\ (HP/GV)$$

where: T_2 = slack side tension, pounds
HP = design horsepower
V = belt speed, feet per minute
G = arc of contact correction factor

Belt Speed

$$V = \frac{(PD)\ (RPM)}{3.82} = (PD)\ (rpm)\ (.262)$$

where: V = belt speed, feet per minute
PD = pitch diameter of sheave or pulley
rpm = revolutions per minute of the same sheave or pulley

* See Table 12 at left

Table 12: Arc of Contact Correction Factor G

D-d / C	Small Sheave Arc of Contact	Factor G	D-d / C	Small Sheave Arc of Contact	Factor G
.00	180°	1.00	.80	133°	.87
.10	174°	.99	.90	127°	.85
.20	169°	.97	1.00	120°	.82
.30	163°	.96	1.10	130°	.80
.40	157°	.94	1.20	106°	.77
.50	151°	.93	1.30	99°	.73
.60	145°	.91	1.40	91°	.70
.70	139°	.89	1.50	83°	.65

D = Diam. of large sheave. d = Diam. of small sheave
C = Center distance

Table 13: Allowable Sheave Rim Speed

Sheave Material	Rim Speed in Feet per Minute
Cast Iron	6,500
Ductile Iron	8,000
Steel	10,000

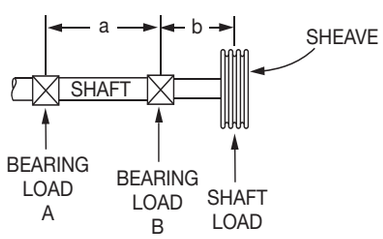
NOTE: Above rim speed values are maximum for normal considerations. In some cases these values may be exceeded. Consult factory and include complete details of proposed application.

Dynamic balance RPM for Sheave/Sprocket ◊ $= \frac{15600}{\sqrt{\text{Dia x Face Width}}}$

◊ **Note:** MPTA recommends Dynamic balance when application RPM exceeds this value.

Bearing Load Calculations

To find actual bearing loads, it is necessary to know machine component weights and values of all other forces contributing to the load. Sometimes it becomes desirable to know the bearing load imposed by the V-belt drive alone. This can be done if you know bearing spacing with respect to the sheave center and shaft load and apply it to the following formulas:

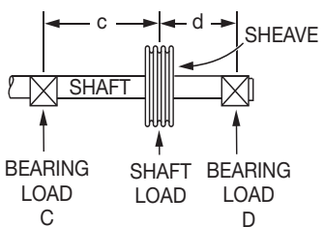


Overhung Sheave

$$\text{Load at B, lbs.} = \frac{\text{Shaft Load x } (a + b)}{a}$$

$$\text{Load at A, lbs} = \text{Shaft Load x } \frac{b}{a}$$

Where: a and b = Spacing, inches



Sheave Between Bearings

$$\text{Load at D, lbs.} = \frac{\text{Shaft Load x c}}{c + d}$$

$$\text{Load at C, lbs} = \frac{\text{Shaft Load x d}}{c + d}$$

Where: c and d = Spacing, inches

Nominal V-Belt Cross Sections

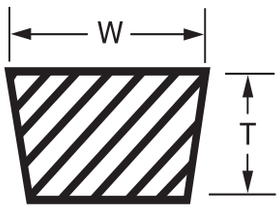


Table 14: Nominal V-Belt Cross Sections

Belt Section	Industry Standard Description	Width W, in Inches	Thickness T, in Inches
3L	FHP, Single	3/8	7/32
4L		1/2	5/16
5L		21/32	3/8
3V	Narrow	3/8	5/16
5V		5/8	17/32
8V		1	29/32
A	Classical Multiple	1/2	5/16
B		21/32	13/32
C		7/8	17/32
D		1-1/4	3/4

Table 15: Maximum Pulley RPM*

Pulley Dia. Inches	FPM												
	100	150	200	250	300	350	400	500	600	700	800	900	1000
6	64	95	127	159	191	223	254	318	382	445	509	573	636
8	48	72	95	119	143	167	191	239	286	334	382	429	477
10	38	57	76	95	115	134	153	191	229	267	305	344	382
12	32	48	64	80	95	111	127	159	191	223	254	286	318
14	27	41	55	68	82	95	109	136	164	191	218	245	273
16	24	36	48	60	72	83	95	119	143	167	191	215	239
18	21	32	42	53	64	74	85	106	127	148	170	191	212
20	19	29	38	48	57	67	76	95	115	134	153	172	191
24	16	24	32	40	48	56	64	80	95	111	127	143	159
30	13	19	25	32	38	45	51	64	76	89	102	115	127
36	11	16	21	27	32	37	42	53	64	74	85	95	106
42	9	14	18	23	27	32	36	45	55	64	73	82	91
48	8	12	16	20	24	28	32	40	48	56	64	72	80
54	7	11	14	18	21	25	28	35	42	49	57	64	71
60	6	10	13	16	19	22	25	32	38	45	51	57	64

* Maximum RPM values shown are based on 6,500 feet per minute for standard cast iron products. For higher rim speeds, contact Dodge Technical Support at 1-864-284-5700
For values not shown use formula below:

$$\text{Max RPM} = \frac{6{,}500}{.2618 \times D}$$

D = Pulley Diameter, Inches

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Table 16: Material Characteristics

MATERIAL	DENSITY (LB/fT3)	ANGLE OF REPOSE (DEG)	RECOMMENDED MAXIMUM INCLINATION
Alfalfa, Ground	16	45˚	
Alum, Lumpy	50 - 60	35˚	
Alum, Pulverized	45 - 50	35˚	
Alumina	60	30˚	10-12
Aluminum Oxide	70 - 120	30˚	
Ammonium Sulphate	45 - 60	45˚	
Asbestos, Shredded	20 - 25	45˚	
Ashes, Dry	35 - 40	45˚	
Ashes, Wet	45 - 50	45˚	
Ashes, Soft Coal	35 - 45	40˚	
Asphalt, Crushed	45	35˚	
Bagasse	7.50	45˚	
Bakelite, Powder	30 - 40	45˚	
Baking Powder	40 - 50	35˚	
Bark, Wood Refuse	10 - 20	45˚	27
Barley	38	25˚	10-15
Basalt	80 - 120	25˚	
Bauxite, Crushed	75 - 85	35˚	20
Beans, Castor, Whole	30 - 45	25˚	8-10
Beans, Cocoa	30 - 45	35˚	
Beans, Navy	50	25˚	
Beans, Whole	45	45˚	
Bentonite, Crude	35 - 40	45˚	
Bentonite, Fine	50 - 60	45˚	
Bones, Pulverized	50 - 60	45˚	
Borax, Fine	50 - 55	35˚	
Borax Coarse	60 - 70	35˚	
Bran	16	35˚	
Brewers Grain, Dry	25 - 35	45˚	
Brewers Grain, Wet	55 - 60	45˚	
Buck Wheat	40	25˚	11-13
Calcium, Carbide	70 - 80	35˚	
Carbon Black, Pellets	25	25˚	
Carbon Black, Powder	5	35˚	
Cast Iron Chips	100 -120	45˚	
Cement, Clinker	75 - 90	35˚	
Cement, Portland	80 -100	35˚	20-23
Chalk, Fine	65 - 75	45˚	
Chalk, Lumpy	80 - 95	45˚	
Charcoal, Wood	15 - 30	35˚	20-25
Chromium Ore	125 - 140	35˚	
Cinders, Coal	40	35˚	20
Clay, Dry, Fine	100 - 120	35˚	20-22
Clay, Dry, Lumpy	60 - 75	35˚	18-20
Coal, Anthracite, Coarse	60 - 70	35˚	18
Coal, Anthracite, Loose	50 - 60	30˚	16
Coal, Bituminous, Coarse	50 - 60	35˚	18
Coal, Bituminous, Loose	45 - 50	35˚	16
Cocoa Nibs	35 - 40	35˚	
Coconut, Shredded	20 - 25	45˚	
Coffee, Fresh Beans	30 - 40	35˚	10-15
Coffee, Roasted Beans	22 - 30	25˚	
Coke, Loose	23 - 32	35˚	18
Coke Pulverized	25 - 35	45˚	20-22
Coke, Petroleum Calcinated	35 - 45	35˚	20
Concrete, Cinder	112	0˚	12-30
Concrete, Gravel & Sand	150	0˚	
Copper Ore	120 - 150	35˚	20
Copper Sulfate	75 - 85	30˚	17
Cork, Ground	5 - 15	45˚	
Corn, On Cob	45	0˚	
Corn, Shelled	45	25˚	10
Corn Sugar	30	35˚	
Corn Grits	40 - 45	35˚	
Cornmeal	32- 40	35˚	22
Cottonseed, Dry, De-Linted	35	35˚	16
Cottonseed, Dry, Not De-Linted	18- 25	45˚	19
Cottonseed, Cake, Lumpy	40- 45	35˚	
Cottonseed, Hulls	12	45˚	
Cottonseed, Meal	35- 40	35˚	22
Cottonseed, Meats	40	35˚	
Cryolite	90-110	35˚	
Cullet	80-120	35˚	20
Diatomaceous Earth	11- 14	35˚	
Dolomite, Lumpy	90-100	35˚	22
Dolomite, Pulverized	46	40˚	
Earth, Dry"	70- 80	35˚	20
Earth, Moist	75-110	40˚	23
Earth, Fullers Dry	30- 35	23˚	20
Emery	225	25˚	
Epsom Salt	40- 50	35˚	
Feldspar, Lumps	70-100	35˚	17
Feldspar, Dust	80-100	40˚	
Fish, Meal	35- 40	40˚	
Fish, Scrap	40- 50	0˚	
Flaxseed, Whole	45	25˚	12
Flaxseed, Meal	25	35˚	
Flour, Wheat	35- 40	45˚	21
Flue Dust, Dry	30- 40	20˚	
Fluorspar, Dust	85- 95	45˚	
Fluorspar, Lumps	80-110	45˚	
Foundry, Refuse	60- 80	35˚	
Foundry Sand, Loose	80- 90	35˚	
Foundry Sand, Rammed	100-110	0˚	
Galena	250	35˚	
Garbage, Average	30	25˚	
Glass, Batch Fiber	45 - 55	10˚	
Glass, Batch Wool	80-100	35˚	20-22
Glass, Broken	80-100	10˚	
Glue, Animal, Flaked	35	25˚	
Glue, Vegetable, Powdered	40	35˚	
Gluten, Meal	39	35˚	
Granite, Lumps	150 -170	25˚	
Graphite, Flakes	40	35˚	
Graphite, Powder	30	25˚	
Graphite, Ore	65 - 75	35˚	
Grass Seed	10	35˚	
Gravel, Dry	90-100	35˚	15-17
Gravel, Wet	100-120	35˚	
Gypsum, Lumps	90-100	35˚	15
Gypsum, Ground	75- 80	35˚	21
Hay, Loose	5	0˚	
Hay, Pressed	25	0˚	
Hominy	35- 50	35˚	
Hops, Spent, Dry	25- 35	45˚	
Hops, Spent, Wet	55- 60	45˚	
Ice, Crushed	35- 40	20-	
Ilmenite Ore	140-160	35˚	
Iron Ore	120-180	35˚	18-20
Iron Ore, Pellets	120-140	35˚	13-15
Iron Sulphate	50- 75	35˚	
Iron Sulfide	120-140	35˚	

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Table 16: Material Characteristics (Continued)

MATERIAL	DENSITY (LB/fT3)	ANGLE OF REPOSE (DEG)	RECOMMENDED MAXIMUM INCLINATION
Kaolin, Clay	60	35°	19
Lactose	30	35°	
Lead Ore, Crushed	180 - 270	30°	
Lead Oxides	60 - 150	40°	
Lead Sulfate	170 - 190	45°	
Lead Sulfide	240 - 260	35°	
Lignite, Air Dried	45 - 55	35°	
Lime, Ground	60 - 65	40°	23
Lime, Hydrated	40	40°	21
Lime, Pebble	30 - 40	40°	17
Limestone, Loose	80 - 100	35°	20
Limestone, Pulverized	85 - 90	45°	18
Linseed, Whole	45 - 50	25°	
Linseed, Meal	30 - 40	35°	20
Magnesium Chloride	30 - 35	40°	
Magnesium Sulfate	40 - 60	35°	
Malt, Dry	25 - 30	30°	
Malt, Wet	60 - 65	45°	
Malt, Meal	35 - 40	35°	
Manganese Ore	125 - 140	40°	
Manganese Oxide	120	35°	
Manganese Sulfate	70	35°	
Manure	25	0°	
Marble, Crushed	80 - 95	35°	
Marl	80	35°	
Mica, Flakes	20	20°	
Mica, Ground	15	35°	23
Milk, Dried, Flaked	5	35°	
Milk, Malted	25 - 35	45°	
Milk, Powdered	20 - 30	40°	
Milo Maize	55 - 60	35°	
Molybdenum Ore	100 - 110	40°	
Mortar, Wet	150	0°	
Niacin	35	35°	
Nickel-Cobalt Sulfate Ore	80 - 150	35°	
Oats	25 - 35	25°	10
Oats, Rolled	20	35°	
Oil Cake	50	45°	
Oxalic Acid Crystals	60	35°	
Oyster Shells, Ground	50 - 60	35°	
Oyster Shells, Whole	80	35°	
Paper Pulp Stock	40 - 60	20°	
Peanuts, Shelled	35 - 45	35°	
Peanuts, Not Shelled	15 - 20	35°	
Peas, Dried	45 - 50	0°	
Phosphate, Fertilizer	50 - 60	35°	30
Phosphate, Rock, Crushed	60 - 100	35°	25
Potash	70 - 80	30°	
Potassium Chloride	120 - 130	35°	
Potassium Nitrate	75 - 80	25°	
Potassium Sulfate	45	45°	
Potatoes, White"	48	0°	
Pumice, Ground	40 - 45	45°	
Pyrites, Lumps	135 - 145	25°	
Pyrites, Pellets	120 - 130	35°	
Quartz, Lumps	95 - 100	25°	
Quartz, Sand	70 - 80	25°	
Rice, Hulled	45 - 50	20°	8
Rice, Rough	35	35°	
Rice, Grits	40 - 45	35°	
Rock, Crushed	100 - 150	30°	

MATERIAL	DENSITY (LB/fT3)	ANGLE OF REPOSE (DEG)	RECOMMENDED MAXIMUM INCLINATION
Rubber, Pellets	50 - 55	35°	22
Rubber, Ground Scrap	25 - 35	45°	18
Rye	42 - 45	25°	8
Rye Meal	35 - 40	20°	
Salt Cake	80 - 95	30°	21
Salt, Coarse"	45 - 55	35°	18-22
Salt, Fine"	70 - 80	35°	11
Sand, Wet	110 - 130	45°	20-22
Sand, Dry	90 - 110	35°	16-18
Sand, Loose, Foundry	80 - 100	35°	22
Sand, Foundry, Rammed	100 - 110	0°	24
Sandstone	80 - 90	35°	
Sawdust	10 - 25	30°	22
Scale, Rolling Mill	125 - 160	45°	
Sewage Sludge, Dry	45 - 55	35°	
Sewage Sludge, Wet	50 - 60	35°	
Shale, Broken	90 - 100	25°	
Shale, Crushed	85 - 90	40°	22
Silica Gel, Dry	45	35°	
Slag, Blast Furnace	80 - 90	25°	10
Slag, Granular, Dry	60 - 65	25°	13-16
Slag, Granular, Wet	90 - 100	45°	20-22
Slate, Ground	80 - 90	30°	15
Slate, Lumps	85 - 95	0°	
Snow, Compacted	15 - 50	0°	
Soap	10 - 25	35°	
Soda Ash, Briquettes	50	20°	7
Soda Ash, Heavy	55 - 65	30°	19
Soda Ash, Light	20 - 35	35°	22
Sodium Aluminum, Ground	72	35°	
Sodium Nitrate, Ground	70 - 80	24°	11
Sodium Phosphate	50 - 65	35°	
Soybeans, Cracked	30 - 40	35°	15-18
Soybeans, Whole"	45 - 50	25°	12-16
Starch, Powdered	25 - 45	25°	12
Steel, Chips	100 - 150	35°	18
Steel, Turnings	60 - 120	45°	
Sugar, Cane, Raw	55 - 65	45°	
Sugar. Granulated, Dry	50 - 55	35°	
Sugar, Granulated, Wet	55 - 65	40°	
Sugar Cane, Knifed	15 - 18	45°	
Sulphur, Lumps	80 - 85	35°	
Sulphur, Dust	50 - 70	35°	
Saconite, Pellets	120 - 140	35°	13-15
Salc, Granulated	50 - 70	20°	
Titanium Dioxide	140	35°	
Titanium Sponge	60 - 70	45°	
Tobacco, Leaves	14	45°	
Tobacco, Scraps	15 - 25	45°	
Tobacco, Stems	15	45°	
Traprock, Crushed	95 - 110	35°	
Traprock, Lumps	100 - 110	35°	
Turf	20 - 30	0°	
Walnut, Shells	35 - 45	35°	
Wheat	48	25°	12
Wheat, Cracked	40 - 45	35°	
Wheat Germ, Dry	20 - 30	25°	27
Wood Chips	10 - 30	45°	22
Zinc Ore, Granular	160	35°	
Zinc Oxide	10 - 35	45°	