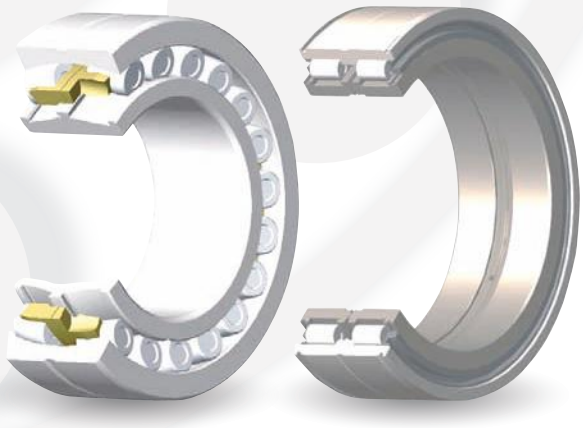
URB

The wise choice for **U**ltra **R**eliable **B**earings

URB GROUP

Bearings for WIND TURBINES small and medium sizes

- Rotor Pitch / Nacelle Yaw
- Gearbox



URB GROUP

320 Republicii Street,
731108 Barlad,
ROMANIA

phone: +40 235 / 411120, 412120
fax: +40 235 / 413838, 308200
www.urbgroup.com

Introduction

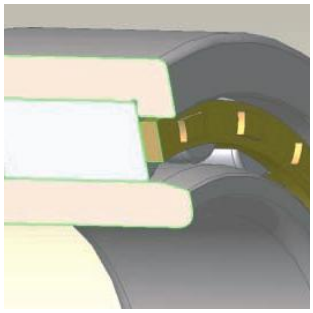
Wind turbine technology continues to progress for increased efficiency, reliability and longer service life of equipment. Innovative bearing designs from URB are instrumental in these improvements and spreading the use of wind technology for electrical power generation.

URB engineers can help specify the bearing type, size to meet critical customer requirements and industry regulations.

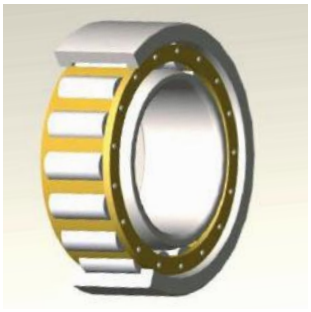
URB supplies a wide range of bearings to specialized industries, including the following commonly used types for wind energy applications:

Cylindrical roller bearings

- Suitable for high radial loads;
- Multi-row and full complement versions available for even higher radial loads;
- Special specifications (optimized geometry) and customized designs available;
- Special cylindrical roller bearing, single row, without outer ring, with crowning inner ring profile;
- For both gearboxes and generators.

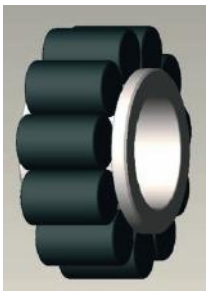


Machined brass cage type EM6



Machined brass cage type EM

Special bearing type NNF..



Special bearing Type 604533...

Designation	Dimensions mm			Basic radial load kN		Weight kg
	d	D	B	dyn.	stat.	
STANDARD BEARINGS						
NU2218 EMASQ1	90	160	40	242	314	3.58
NJ2220 EMSQ1	100	180	46	319	418	5.22
NJ2320 EMSQ1	100	215	73	570	717	13.94
NU2320 EMSQ1	100	215	73	570	717	13.71
NJ2222 EMSQ1	110	200	53	383	516	7.75
NU2222 EMSQ1	110	200	53	383	516	7.22
NU222 EMSQ1	110	200	38	279	343	5.29
NJ2322 EMASQ1	110	240	80	667	868	19.36
NJ322 EMSQ1	110	240	50	443	513	11.66
NJ2324 MC3SQ1	120	260	86	702	907	23.22
NJ2224 EMSQ1	120	215	58	446	609	9.16
NU2224 EMSQ1	120	215	58	446	609	9.16
NJ324 EMSQ1	120	260	55	549	644	14.99
NU326 EM6SQ1	130	280	58	607	722	18.49
NJ2226 EMSQ1	130	230	64	523	726	11.83
NU2226 EMSQ1	130	230	64	523	726	11.6
NJ2326 EM6SQ1	130	280	93	909	1212	29.44
NU2326 EM6SQ1	130	280	93	909	1212	28.97
NU226 EMSQ1	130	230	40	356	443	7.1
NJ228 EMSQ1	140	250	42	372	479	9.24
NU2228 EM6SQ1	140	250	68	543	780	15.22
NU2328 EMASQ1	140	300	102	1130	1589	35.5
NJ2230 EMSQ1	150	270	45	631	922	19.22
NJ2330 EMASQ1	150	320	108	1223	1710	45.64
NU330 EMASQ1	150	320	65	798	988	27.85

Designation	Dimensions mm			Basic radial load kN		Weight kg
	d	D	B	dyn.	stat.	
NU230 EMSQ1	150	270	45	422	550	11.67
NJ2332 EMSQ1	160	340	114	1312	1819	52.183
NJ2232 EMSQ1	160	290	80	767	1109	24.51
NU2232 EMSQ1	160	290	80	767	1109	24.15
NU232 EMSQ1	160	290	48	498	666	14.61
NU2234 EMASQ1	170	310	86	914	1316	28.57
NJ2334 EMSQ1	170	360	120	1226	1758	62.08
NJ234 EMSQ1	170	310	52	618	828	19.22
NU2336 EMSQ1	180	320	86	955	1408	30.48
NU2338 EM6SQ1	190	400	132	1789	2628	85.7
NJ2240 EMSQ1	200	360	98	1220	1860	43.599
NU2240 EMSQ1	200	360	98	1220	1860	42.83
NU1048 MSQ1	240	360	56	695	1168	21.19
NU1068 MSQ1	340	520	82	1117	1817	62.7
SPECIAL BEARINGS						
NNF5013 VS094FW99A-2RSR	65	100	46	134	236	1.28
NNF5017 VS094FW99A-2RSR	85	130	60	281	456	2.78
NNF5018 VS094FW99A-2RSR	90	140	67	307	546	3.61
NNF5022 VS094FW99A-2RSR	110	170	80	395	724	6.39
NNF5034 VS094FW99A-2RSR	170	260	122	1059	2059	22.11
NNF260 VS094FW99A-2RSR	260	340	95	983	2028	21.7
NNF5024 VS094FW99A-2RSR	120	180	80	412	780	6.84
NNF5028 VS094FW99A-2RSR	140	210	94	681	1234	10.77
604533-00162/2	420	506.726*	55	1010	2350	16.284
604533-00163/2	240	287.954*	32	333	735	3.617
604533-00164	217	259.47*	29	280	595	2.612
604533-00168/2	270	322.14*	38	460	950	5.126
604533-00169	300	356.575*	38	485	1060	6.33
604533-00170	325	383.42*	43	600	1330	7.799
604533-00171/2	375	406.5*	48	830	1860	12.402
604533-00172/2	485	575.13*	66	1340	3200	28.350
604533-00214	25	53.55*	28	79	77	0.263
604533-00215	30	60.49*	28	91	94	0.333
604533-00216/2	30	68.15*	31.5	114	112	0.496
604533-00217/2	35	73.02*	35	136	145	0.613
604533-00218/2	40	81.4*	37.5	165	199	0.849
604533-00219/2	45	93.47*	45	220	264	1.341
604533-00220/2	50	109.27*	50	268	286	1.92
604533-00221	80	147.14*	67.5	468	629	4.451
604533-00222/2	70	134.75*	60	408	489	3.361
604533-00223/2	80	147.14	67.5	468	629	4.451
604533-00224/1349696	90	176.21	80	636	780	7.319
604533-00228/2	550	652.2*	55	1420	2900	28.126
604533-00229	110	233.7*	100	1045	1280	17.693
604533-00231/2	600	690.05*	60	1470	3850	32.819
604533-00233/2	50	109.27*	50	220	206	1.83
604533-00236/2	40	81.4*	37.5	132	140	0.799
604533-00239/2	30	60.49*	28	70	66	0.318

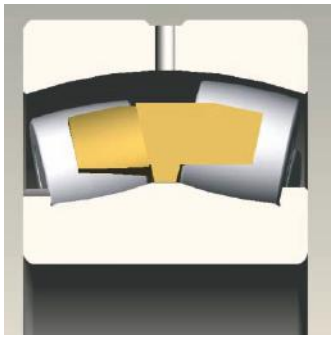
** E dimensions*

Cylindrical roller bearings are very often used because of their high radial load capacity.
The ability to accommodate angular misalignment is limited and has to be considered according to the manufacturers guidelines. The bearings with black oxide-coated offers protection at corrosion and substances, thus they have a good behavior at harsh environments.

Appropriate condition for axial loading is achieved when the ratio between axial and radial load Fa/Fr is less than 0.4 and viscosity ratio κ is higher than 2.

Spherical roller bearings

- Suitable for large radial loads and low to medium speeds;
- Allows compensation for misalignment;
- Usually for main shafts and gear.



Machined brass cage type CA

Machined brass type MB

Designation	Dimensions mm			Basic radial load kN		Weight kg
	d	D	B	dyn.	stat.	
22217 MBW33	85	150	36	230	295	2.75
22319 MBW33	95	200	67	570	740	9.97
22320 MBW33	100	215	73	670	880	13.78
22322 MBW33	110	240	80	800	1060	18.7
22324 MBW33	120	260	86	930	1230	23.18
22226 MBW33	130	230	64	600	880	11.47
22326 MBW33	130	280	93	1080	1450	28.25
22234 MBW33	170	310	86	1080	1610	27.51
23134 MBW33	170	280	88	990	1650	21.41
24134 CAW33	170	280	109	1280	2230	27.41
24136 CAW33	180	300	118	1460	2590	32.96
23238 MBW33	190	340	120	1610	2640	47.83
23240 MBW33	200	360	128	1620	2590	57.7
24144 MBW33	220	370	150	1780	3109	65.44
23244 MBW33	220	400	144	1850	2899	80.62
23948 MBW33	240	320	60	600	1170	13.32
23152 MBW33	260	440	144	2025	3391	88.93
23956 MBW33	280	380	75	880	1749	24.76
23960 MBW33	300	420	90	1263	2495	39.23
23964 MBW33	320	440	90	1225	2468	40.92
23064 MBW33	320	480	121	1808	3471	77.84
23972 MBW33	360	480	90	1312	2792	46.22
23984 CAW33	420	560	106	1830	4060	73.19

Spherical roller bearings have a high radial loading capacity and can accommodate a higher degree of misalignment. Consequently the operating conditions such as the ratio Fa/Fr, and the ratio between roller diameter and roller length, low radial loads as well as the risk of a considerable amount of skidding has to be carefully evaluated.

Calculation of rating life

For a preliminary selection of bearings in the design process of the gearbox, the basic rating life calculation should be used according ISO 281.

$$L_{10h} = \frac{10^6}{60 \cdot n}\left(\frac{C}{P}\right)^p$$

where

L10h is basic rating life, hours;
n is rotational speed, rpm;
C is basic dynamic load rating according to ISO 281, N;
P is dynamic equivalent bearing load, N;
p is life exponent (3 for ball bearings and 10/3 for roller bearings).

Minimum basic rating life, L_{10h}

Bearing position	Required life, L_{10h}, hr
High speed shaft	30,000
High speed intermediate shaft	40,000
Low speed intermediate shaft	80,000
Planet	100,000
Low speed shaft	100,000

Note:
Values in this table are valid for a design life of 20 years and shall be adjusted for designs with different design life.

Modified reference rating life L_{nmr} shall be calculated in accordance ISO/TS 16281.
The modified reference rating life L_{nmr} shall include the effects of:

- Radial, axial and moment loads;
- Load sharing between rolling elements;
- Load distribution along the roller length considering actual roller and raceway profiles;
- Load distribution on flanges of bearings;
- Elasticity of bearing, shaft and housing;
- Internal design of the bearing, hereunder roller- and raceway profiling;
- Truncation of contact area;
- Operating misalignment between inner and outer rings;
- Operating internal clearance considering initial clearance, shaft and housing fit, and temperature of inner and outer rings;
- Operating lubricant viscosity and required lubricant viscosity for full hydrodynamic lubrication condition;
- Operating lubricant cleanliness;
- The effectiveness of the additive system at low viscosity ratio k in accordance with ISO 281;

Such advanced methods shall be used in the design phase of a wind turbine gearbox. The advanced rating life shall be greater than the specified design life of the wind turbine.

The calculations shall be performed bin-by-bin using the load spectrum specified by the wind turbine manufacturer. Combined modified reference rating life L_{nmr} shall be calculated by use of equation:

$$L_{nmr} = a_1 \cdot \frac{\sum q_i}{\sum \frac{q_i}{L_{10mr,i}}}$$

where

L_{nmr} is combined modified reference rating life in hours at (100-n)% reliability
n is the reliability expressed as a percentage of failures
a_1 is the life adjustment factor for reliability per ISO 281
$L_{10mr,i}$ is the adjusted modified reference rating life for the ith load level at 90% reliability per ISO/TS 16281
q_i is the percent percentage of time or revolutions of the ith load level

Contact stress

The contact stress using the Miner's sum dynamic equivalent bearing load should not exceed the values listed in the below table:

Values for maximum contact stress for rolling element bearings

Bearing position	Maximum contact stress, p_{max}, MPa
High speed shaft	1300
High speed intermediate shaft	1650
Low speed intermediate shaft	1650
Planet	1450
Low speed shaft	(there is no equivalent load on the input shaft)

Note:
Values in this table are valid for a design life of 20 years and shall be adjusted for designs with different design life.

Bearing failures

ISO 15243 is a useful standard to classify the damage. The accompanying table provides a few examples of bearing failures in the wind industry. Note that damage classification is not a root cause of failure. One or more initiating factors are often behind the observed damage.

The recently revised standard for wind turbine gearbox designs, ISO 61400-4, requires sizing gearbox bearings per ISO 281 and ISO 76, which include calculations for two failure modes:

- Sub-surface initiated, rolling contact fatigue and
- Yielding under maximum stress.

The standard also mandates items such as bearing steel quality (to meet ISO 683-17).

Common bearing failure modes in wind turbine drive trains

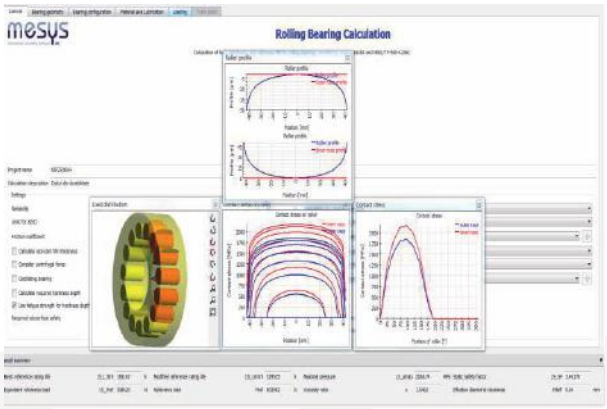
Damage	Also called	Component affected
Micro-pitting	Grey staining	Spherical rollers in main bearings (main rotor shaft bearings)
White etching area (WEA) cracking	Axial cracks	Through hardened cylindrical roller bearings on gearbox parallel stage shafts
Electrical erosion	1) Fluting 2) EDM	Generator bearings
Fatigue	Spalling	1) Tapered roller bearings on gearbox parallel stage shafts 2) Planet bearings

Calculation and Selection

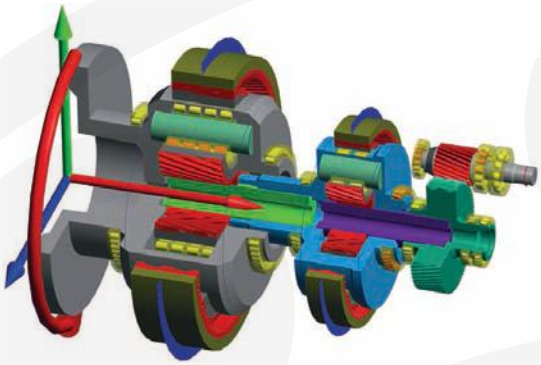
Rulmenti SA, Barlad use computer programs with finite element simulation taking into account internal bearing geometry and operating conditions.

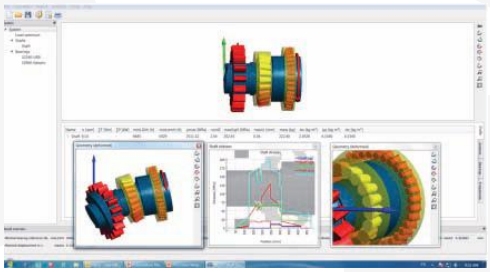
The Shaft Calculation calculates the deflections, internal forces and the natural frequencies of several shafts connected by boundary conditions.

In addition to the possibilities of the Shaft Calculation the system calculation allows to calculate shaft systems. Parallel and non parallel shafts and planetary stages can be coupled by gear connections.

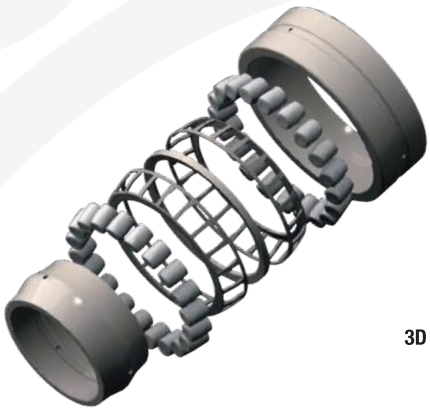


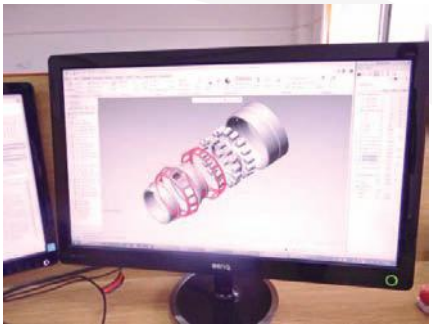
Rolling Bearing Calculation



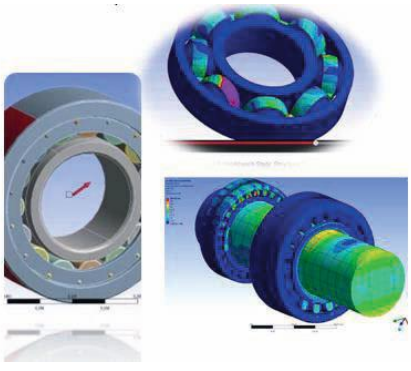


Shaft Calculation





3D Modeling



Finite Element Analysis (FEA)

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URB Company with over 60 years experience in designing bearings has the ability to continuously develop new products and services that improve our clients' products. For these investments in technology and specialists specialized software for the calculation and optimization of the existing construction, new materials, metal coatings have been made, increasing the lifetime of our products.

An important factor of quality is continuing design improvement (tapered ribs and roller end crowning to increase the axial load capacity), optimizes lubrication, increases loading capacity, minimizes edge stresses and use polymer cage.

The company was set-up on May 1953 and it has a long tradition in manufacturing of bearings over 60 years, being one of the important bearing manufactures in the Central and South-East Europe.

The key to success has been a consistent emphasis on maintaining the highest quality of our products and services and investment in research and development.

We include the respect for clients and the satisfaction of their needs among our fundamental principles. Therefore we tried to respond better to the market requirements by offering, besides the bearings with standardized shapes and sizes, a large range of non-standardized bearings, specific to various applications.