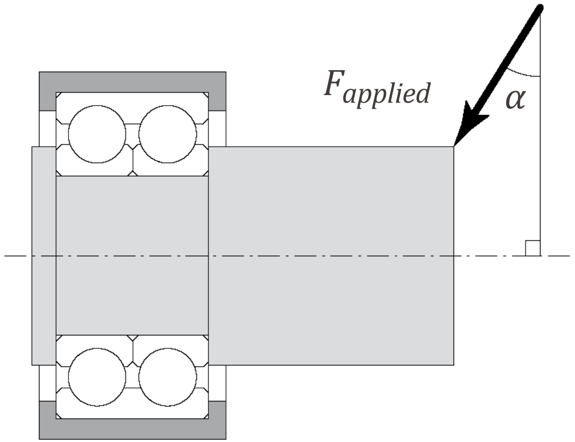
EE580 Space Mechanisms – Quiz 3

http://tiny.cc/EE580Q03

Quiz

- An ADR thin section super duplex bearing WAD725 has been selected to support a cantilever axis, on which is applied a pure force $F_{applied}$ = 235 N, with an angle α = 30°. The selected super duplex bearing has a contact angle of 15° (O-mount). What is the estimated nominal life of this super duplex bearing?



- Hint: use ADR catalogue ([6.3] on MOODLE)

Quiz

- The stiffness of a structure is measured by:
  - The ratio of a force by a surface — Stress: $\sigma = E \cdot \varepsilon$
  - The ratio of torque by an angle — Angular stiffness: $\gamma = \frac{M}{\alpha}$
  - The ratio of a length by a length — Strain: $\varepsilon = \frac{\Delta l}{l}$
  - The ratio of a force by a length — **Stiffness**: $\boldsymbol{k} = \frac{\boldsymbol{F}}{\Delta \boldsymbol{l}}$
  - The ratio of a stress by a strain — Young's modulus: $E = \frac{\sigma}{\varepsilon}$

Quiz

- In the list below what are the preferred materials used for space ball-bearings?
  - 100Cr6 / SAE 52100
  - X105CrMo17 / AISI 440
  - 80MoCrV40 / M50
  - X115CrMoV14.4.1 / AMS 5749
  - HS 18-0-1 / AMS 5626

Quiz

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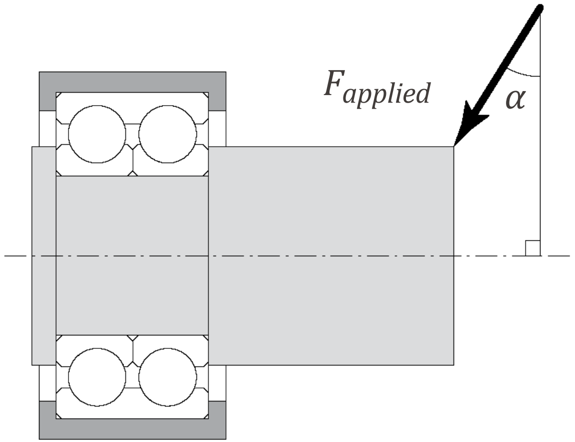
- **373 million revolutions**



- Hint: use ADR catalogue ([6.3] on MOODLE)

EPFL

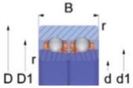
Quiz

C • Thin-section ball bearings

Bore diameter d from .6250 inch (d 15,875 mm) to 2.5625 inch (d 65,0875 mm)

2 • Series AD7, super duplex

Constant ball diameter: 3/32 inch (2,381 mm)
Constant section
Versions H, N and B
Duplex configuration back-to-back
Preload value upon request
Tolerances: TA5, TA4



Source: ADR

Basic designation	Dimensions *in inches* in mm						Basic load rating² N			Mean² mass
							Radial		Axial	
							Dyn.	Stat.	static	
	d	D	B	d1	D1	r¹	C	Co	Cax	g
WAD710	*.625* 15,875	*1.0625* 26,9875	*.375* 9,525	*.7661* 19,46	*.8827* 22,42	*.015* 0,38	2200	2100	1620	21
WAD712	*.75* 19,05	*1.1875* 30,1625	*.375* 9,525	*.8909* 22,63	*1.0075* 25,59	*.015* 0,38	2300	2340	1840	24
WAD713	*.8125* 20,6375	*1.25* 31,75	*.375* 9,525	*.9535* 24,22	*1.0701* 27,18	*.015* 0,38	2340	2460	1950	25
WAD714	*.875* 22,225	*1.3125* 33,3375	*.375* 9,525	*1.0161* 25,81	*1.1327* 28,77	*.015* 0,38	2390	2590	2070	27
WAD717	*1.0625* 26,9875	*1.5* 38,1	*.375* 9,525	*1.2035* 30,57	*1.3201* 33,53	*.015* 0,38	2510	2950	2400	31
WAD721	*1.3125* 33,3375	*1.75* 44,45	*.375* 9,525	*1.4535* 36,92	*1.5701* 39,88	*.015* 0,38	2720	3570	2960	37
WAD725	*1.5625* 39,6875	*2* 50,8	*.375* 9,525	*1.7035* 43,27	*1.8201* 46,23	*.015* 0,38	2840	4060	3410	43

$$F_{axial} = F_{applied}\,\mathrm{Sin}(30°) = 117.5\mathrm{N}$$

$$F_{radial} = F_{applied}\,\mathrm{Cos}(30°) = 203.5\mathrm{N}$$

Factors X and Y and Factors X_o and Y_o

In the table below, note that:

1 • For the DO or DX pairs, take $2F_a$ and the value C_o of the pair.

2 • For the DO or DX pairs, X0 and Y0 are to be multiplied by 2.

3 • The values of X, Y and e to be retained for intermediate contact angles are obtained by linear interpolation.

Source: ADR

Contact³ angle	$\frac{F_a}{C_o}$ ¹	e	Single bearing or DT pair						DO or DX pairs			
			$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		X_o ²	Y_o ²	$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
			X	Y	X	Y			X	Y	X	Y
	0.014	0.23				2.30				2.78		3.74
	0.028	0.26				1.99				2.40		3.23
	0.056	0.30				1.71				2.07		2.78
	0.085	0.34				1.55				1.87		2.52
5°	0.110	0.36	1	0	0.56	1.45	0.6	0.5	1	1.75	0.78	2.36
	0.170	0.40				1.31				1.58		2.13
	0.280	0.45				1.15				1.39		1.87
	0.420	0.50				1.04				1.26		1.69
	0.560	0.52				1.00				1.21		1.63
	0.014	0.29				1.88				2.18		3.06
	0.029	0.32				1.71				1.98		2.78
	0.057	0.36				1.52				1.76		2.47
	0.086	0.38				1.41				1.63		2.29
10°	0.110	0.40	1	0	0.46	1.34	0.6	0.5	1	1.55	0.75	2.18
	0.170	0.44				1.23				1.42		2.00
	0.290	0.49				1.10				1.27		1.79
	0.430	0.54				1.01				1.17		1.64
	0.570	0.54				1.00				1.16		1.63
	0.015	0.38				1.47				1.65		2.39
	0.029	0.40				1.40				1.57		2.28
	0.058	0.43				1.30				1.46		2.11
	0.087	0.46				1.23				1.38		2.00
15°	0.120	0.47	1	0	0.44	1.19	0.5	0.46	1	1.34	0.72	1.93
	0.170	0.50				1.12				1.26		1.82
	0.290	0.55				1.02				1.14		1.66
	0.440	0.56				1.00				1.12		1.63
	0.580	0.56				1.00				1.12		1.63

$$\frac{2 \cdot F_{axial}}{C_o} = 0.0579 \qquad \frac{F_{axial}}{F_{radial}} = 0.58 > \mathrm{e}$$

$$P = 0.72 \cdot F_{radial} + 2.11 \cdot F_{axial} = 395.5 \quad [\mathrm{N}]$$

$$L_{10} = \left(\frac{C}{P}\right)^3 = 373 \quad [10^6 \text{ revolutions}]$$