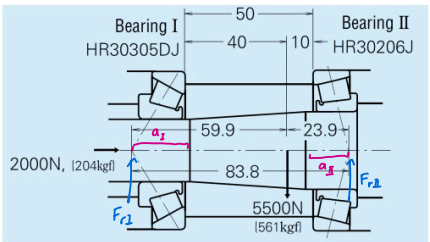
Ex 3) Bearings Selection (tap. roller)

- **Determine bearing life L_{10} and L_h ($n = 600$ rpm)**



I : HR30305 DJ
II : HR 30206 J
} B2B Arrangement

d	D	T	B	C	Cone r min.	Cup r min.	Basic Load Ratings (N) C_r	C_{0r}	(kgf) C_r	C_{0r}	Limiting Speeds (r/min) Grease	Oil	Bearing Numbers	ISO355 Dimension Series approx.	d_a min.	d_a max.	d_b max.	D_a max.	D_b min.	S_a min.	S_b min.	Cone r max.	Cup r max.	Eff. Load Centers (mm) d	e	Constant Y1	Constant Y0	Mass (kg) approx.
15	35	11.75	11	10	0.6	0.6	14 800	13 200	1 510	1 350	11 000	15 000	30202	—	23	19	20	30	33	2	1.5	0.6	0.6	8.2	0.32	1.9	1.0	0.053
	42	14.25	13	11	1	1	23 600	21 100	2 400	2 160	9 500	13 000	HR 30202 J	2FB	24	22	26	36	38.5	2	3	1	1	9.5	0.29	2.1	1.2	0.098
17	40	13.25	12	11	1	1	20 100	19 900	2 050	2 030	9 500	13 000	HR 30203 J	2DB	26	23	34	34	37.5	2	3	1	1	9.7	0.35	1.7	0.96	0.079
	47	17.25	16	14	1	1	27 100	28 000	2 770	2 860	9 500	13 000	HR 32203 J	2DD	26	22	34	34	37	2	3	1	1	11.2	0.31	1.9	1.1	0.103
	47	15.25	14	12	1	1	29 200	26 700	2 980	2 720	8 500	12 000	HR 30303 J	2FB	26	24	41	40	43	2	3	1	1	10.4	0.29	2.1	1.2	0.134
	47	15.25	14	10.5	1	1	22 000	20 300	2 240	2 070	8 000	11 000	HR 30303 D	—	29	23	41	34	44	2	4.5	1	1	15.4	0.81	0.74	0.41	0.129
	47	20.25	19	16	1	1	37 500	36 500	3 800	3 750	8 500	11 000	HR 32303 J	2FD	29	23	41	43	44	2	4	1	1	12.5	0.29	2.1	1.2	0.179
20	42	15	15	12	0.6	0.6	24 600	27 400	2 510	2 800	9 000	12 000	HR 32004 XJ	3CC	28	24	37	35	40	3	3	0.6	0.6	10.6	0.37	1.6	0.88	0.097
	47	15.25	14	12	1	1	27 500	28 500	2 850	2 900	8 000	11 000	HR 30204 J	2DB	29	27	41	40	44	2	3	1	1	11.0	0.35	1.7	0.96	0.122
	47	15.25	14	12	0.3	1	23 900	24 000	2 430	2 450	8 000	11 000	HR 30204 C A-	—	29	26	41	37	44	2	3	0.3	1	13.0	0.55	1.1	0.60	0.126
	47	19.25	18	15	1	1	32 500	37 500	3 650	3 850	8 000	11 000	HR 32204 J	2DD	29	25	41	38	44.5	2	4	1	1	12.6	0.33	1.8	1.0	0.161
	47	19.25	18	15	1	1	31 500	33 500	3 200	3 400	8 000	11 000	HR 32204 CJ	5DD	29	25	41	36	44	2	4	1	1	14.5	0.52	1.2	0.64	0.166
	52	16.25	15	13	1.5	1.5	35 000	33 500	3 550	3 400	7 500	10 000	HR 30304 J	2FB	31	27	44	44	47.5	2	3	1.5	1.5	11.6	0.30	2.0	1.1	0.172
	52	16.25	15	12	1.5	1.5	29 300	24 500	2 980	2 490	7 100	10 000	HR 30304 D	—	34	26	43	37	49	2	4	1.5	1.5	16.7	0.81	0.74	0.41	0.168
	52	22.25	21	18	1.5	1.5	45 500	47 500	4 650	4 850	8 000	11 000	HR 32304 J	2FD	33	26	43	42	48	3	4	1.5	1.5	13.9	0.30	2.0	1.1	0.241
22	44	15	11.5	0.6	0.6		25 600	29 400	2 610	3 000	8 500	11 000	HR 32022 XJ	3CC	30	27	39	37	42	3	3.5	0.6	0.6	11.1	0.40	1.5	0.83	0.103
	50	15.25	14	12	1	1	29 200	30 500	2 980	3 150	7 500	10 000	HR 30222	—	31	29	44	42	47	2	3	1	1	11.6	0.37	1.6	0.90	0.139
	50	15.25	14	12	1	1	27 200	29 500	2 780	3 000	7 500	10 000	HR 30222 C	—	31	29	44	40	47	2	3	1	1	13.0	0.49	1.2	0.67	0.144
	50	19.25	18	15	1	1	36 500	40 500	3 750	4 100	7 500	11 000	HR 32222	—	31	28	44	41	47	2	4	1	1	13.5	0.37	1.6	0.89	0.18
	50	19.25	18	15	1	1	33 500	39 500	3 400	4 050	7 500	10 000	HR 32222 C	—	31	29	44	39	48	2	4	1	1	15.2	0.51	1.2	0.65	0.185
	56	17.25	16	14	1.5	1.5	37 000	36 500	3 750	3 750	7 100	9 500	HR 30322	—	33	30	47	46	50	2	3	1.5	1.5	12.4	0.32	1.9	1.0	0.208
	56	17.25	16	13	1.5	1.5	34 500	34 000	3 500	3 500	6 700	9 500	HR 30322 C	—	33	30	47	44	52.5	3	4	1.5	1.5	15.9	0.59	1.0	0.56	0.207
25	47	15	11.5	0.6	0.6		27 400	33 000	2 800	3 400	8 000	11 000	HR 32005 XJ	4CC	33	32	42	40	45	3	3.5	0.6	0.6	11.8	0.43	1.4	0.77	0.116
	47	17	17	14	0.6	0.6	31 000	38 000	3 150	3 900	8 000	11 000	HR 33005 J	2CE	33	29	42	41	44	3	3	0.6	0.6	11.0	0.29	2.1	1.1	0.137
	52	16.25	15	13	1	1	32 000	35 000	3 300	3 550	7 100	10 000	HR 30205 J	3CC	34	31	46	44	48.5	2	3	1	1	12.7	0.37	1.6	0.88	0.157
	52	16.25	15	12	1	1	28 100	31 500	2 860	3 200	9 700	9 500	HR 30205 C	—	34	32	46	43	49.5	2	4	1	1	14.4	0.53	1.1	0.62	0.155
	52	19.25	18	16	1	1	40 000	45 000	4 050	4 600	7 100	10 000	HR 32205 J	2CD	34	30	46	44	50	2	3	1	1	13.5	0.36	1.7	0.92	0.189
	52	19.25	18	15	1	1	35 000	42 000	3 550	4 250	7 100	9 500	HR 32205 C	—	34	30	46	40	50	2	4	1	1	15.8	0.53	1.1	0.62	0.19
	52	22	22	18	1	1	47 500	56 500	4 850	5 750	7 500	10 000	HR 33205 J	2DE	34	29	46	43	49.5	4	4	1	1	14.1	0.35	1.7	0.94	0.227
	62	18.25	17	15	1.5	1.5	47 500	46 000	4 850	4 700	6 300	8 500	HR 30305 J	3FB	36	34	54	54	57	3	3.5	1.5	1.5	13.7	0.35	2.0	1.1	0.271
	62	18.25	17	14	1.5	1.5	42 000	45 000	4 300	4 550	6 000	8 500	HR 30305 C	—	36	35	53	49	58.5	3	4	1.5	1.5	16.4	0.55	1.1	0.60	0.276
	62	18.25	17	13	1.5	1.5	38 000	40 500	3 900	4 100	5 600	8 000	HR 30305 DJ	4FB	39	34	53	47	59	3	5	1.5	1.5	19.9	0.83	0.73	0.40	0.266
	62	18.25	17	13	1.5	1.5	38 000	40 500	3 900	4 100	5 600	8 000	HR 31305 J	7FB	39	33	53	47	59	3	5	1.5	1.5	19.9	0.83	0.73	0.40	0.265

d	D	T	B	C	Cone r min.	Cup r min.	Basic Load Ratings (N) C_r	C_{0r}	(kgf) C_r	C_{0r}	Limiting Speeds (r/min) Grease	Oil	Bearing Numbers	ISO355 Dimension Series approx.	d_a min.	d_a max.	d_b max.	D_a max.	D_b min.	S_a min.	S_b min.	Cone r max.	Cup r max.	Eff. Load Centers (mm) d	e	Constant Y1	Constant Y0	Mass (kg) approx.
30	47	12	12	9	0.3	0.3	17 600	24 400	1 800	2 490	7 500	10 000	HR 32906 J	2BD	34	34	44	42	44	3	3	0.3	0.3	9.2	0.32	1.9	1.0	0.074
	55	17	17	13	1	1	36 000	44 500	3 700	4 550	6 700	9 000	HR 32906 XJ	4CC	39	35	49	47	53	3	4	1	1	13.6	0.43	1.4	0.77	0.172
	55	20	20	16	1	1	42 000	54 000	4 250	5 500	6 700	9 000	HR 33006 J	2CE	39	35	49	48	52	3	4	1	1	13.1	0.29	2.1	1.1	0.208
	62	17.25	16	14	1	1	43 000	47 500	4 400	4 850	6 000	8 000	HR 30206 J	3DB	39	37	56	52	58	3	3	1	1	13.9	0.37	1.6	0.88	0.239
	62	17.25	16	12	1	1	35 500	37 000	3 650	3 800	5 600	7 500	HR 30206 C	—	39	36	56	49	59	3	5	1	1	17.9	0.66	0.88	0.48	0.231
	62	21.25	20	17	1	1	52 000	60 000	5 300	6 150	6 000	8 500	HR 32206 J	3DC	39	36	56	51	58.5	2	4	1	1	15.4	0.37	1.6	0.88	0.297

$a_I = 19.9$

$a_{II} = 13.9$

Moments:

$$(50 + a_I + a_{II})\, F_{rI} = 5500 \times (10 + a_{II}) \Rightarrow F_{rI} = 5500 \times \frac{23.9}{83.8} = 1569\ N$$

$$(83.8)\, F_{rII} = 5500\,(40 + a_I) \Rightarrow F_{rII} = 5500 \times \frac{40 + a_I}{83.8} = 5500 \times \frac{59.9}{83.8} = 3931\ N$$

From catalogue:

I : $C = 38400\ N$, $C_0 = 40500\ N$, $e_I = 0.83$, $Y_I = 0.73$

II : $C = 43000\ N$, $C_0 = 47500\ N$, $e_{II} = 0.37$, $Y_{II} = 1.6$

$$F_{ae} + \frac{0.6}{Y_{II}} F_{rII} = 2000 + \frac{0.6}{1.6}\, 3931 = 3474\ N$$

$$\frac{0.6}{Y_I} F_{rI} = \frac{0.6}{0.73} \times 1569 = 1290\ N$$

$$\therefore F_{ae} + \frac{0.6}{Y_{II}} F_{rII} > \frac{0.6}{Y_I} F_{rI}$$

This means axial load $F_{ae} + \frac{0.6}{Y_{II}} F_{rII}$ is applied to bearing I but not to II.

Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \le e$		$F_a/F_r > e$	
X	Y	X	Y
1	0	0.4	Y_1

Static Equivalent Load

$P_0 = 0.5F_r + Y_0F_a$

When $F_r > 0.5F_r + Y_0F_a$, use $P_0 = F_r$

The values of e, Y_1, and Y_0 are given in the table below.

Thus, $F_{aI} = F_{ae} + \frac{0.6}{Y_I} F_{rII} = 3474$ N

$\frac{F_{aI}}{F_{rI}} = \frac{3474}{1569} > e_I = 0.83 \Rightarrow X = 0.4,\ Y = 0.73$

$\Rightarrow P_I = XF_{rI} + Y_I F_{aI}$

$= 0.4(1569) + 0.73(3474) = 3164$ N

$L_{10,I} = \left(\frac{C_I}{P_I}\right)^{\frac{10}{3}} =$ **3967 million rev's**

For bearing II, $P_{II} = F_{rII} = 3931$ N

$L_{10,II} = \left(\frac{C_I}{P_I}\right)^{\frac{10}{3}} =$ **2906 million revs**

Assume the shaft runs at $n = 600$ rpm. Then,

$L_{h,I} = \frac{L_{10,I} \times 10^6}{60 \times 600} =$ **110,200 hours**

$L_{h,II} = \frac{L_{10,II} \times 10^6}{60 \times 600} =$ **80,708 hours**

Static load factors:

Bearing I — $F_{rI} = 1569$ and $0.5F_{r1} + Y_{01}F_{a1} = 0.5 \times 1569 + 0.4 \times 3474 = 2174$

$P_{o1} = 0.5F_{r1} + 0.4F_{aI} = 2174$ N

$f_{s,1} = \frac{C_{o1}}{P_{o1}} = \frac{40500}{2174} =$ **18.6**

Bearing II — $F_{rII} = 3931$ and $F_{aII} = 0$. Thus

$P_{oII} = F_{rII}$

$f_{s,II} = \frac{C_{o,II}}{P_{o,II}} = \frac{47500}{3931} =$ **12.1**