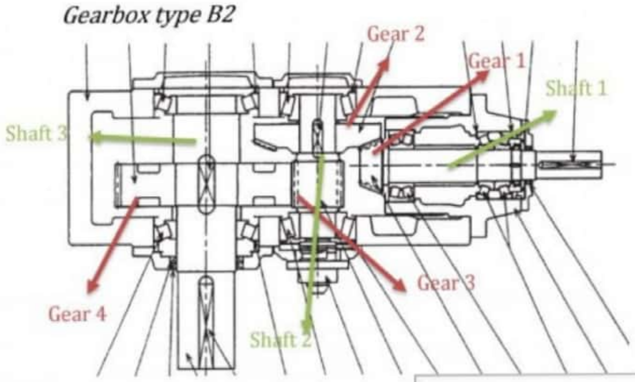
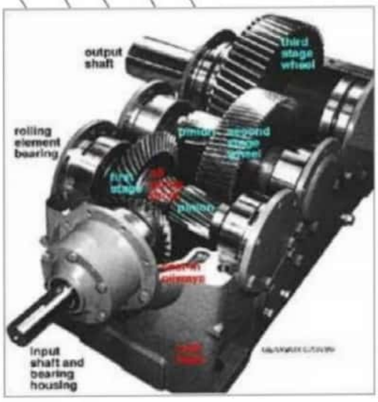
Gearbox type B2





The first phase of the project :

Search for an acceptebale gearbox in catalog

As shown in the pictures, The gearbox is designed to reduce the speed so:

$$e = \frac{\omega_{in}}{\omega_{out}} \rightarrow \omega_{out} = \frac{\omega_{in}}{e} = \frac{1400}{15.4} = 90.91\ rpm$$

Assume the application is Moderate shock in 10 years of work

$\rightarrow F_m = 1.5\ (table\ 1)$

Unidirectional and just one shift per day (one start and stop)

$\rightarrow F_s = 1\ (table\ 3)$

We have the absorbed power $P_a = 75.7\ (KW)$ *so The required mechanical capacity* P_R *is :*

$P_R = P_a \times F_m = 75.7 \times 1.5 = 113.55\ (KW)$

The unit capacity:

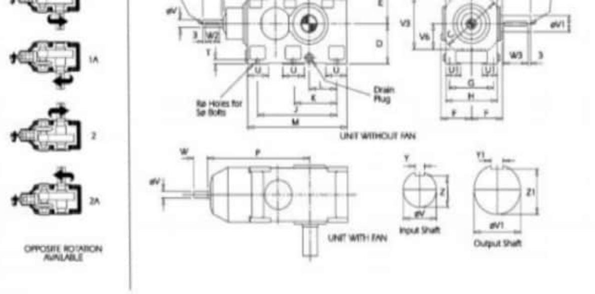
$P_c = P_m \times F_s = P_m \times 1 = P_m$

On the other hand it must be:

$P_c > P_R \rightarrow P_m > P_R \rightarrow P_m > 113.55\ (KW)$

So we have to find a bigger number than that in the catalog tables(page 66-69) for B2, 1400 rpm, e(15.4)

	H200	H225	H250
1450	84.4	122	165
1400	x	y	z
960	55.9	81	110



Unit Size	A	B	C	D	E	F	G	H	J	K	L	M	N	P	P1	Q	R	S	T	U
140	140	390	300	160	174	135	190	224	335	-	120	425	165	435	395	140	13.5	4 x 12	20	100
160	160	430	350	180	194	155	225	260	375	-	135	475	185	475	435	160	17.5	4 x 16	20	110
180	180	480	375	200	214	173	250	290	425	-	147.5	530	200	530	485	175	17.5	4 x 16	25	120
200	200	520	400	225	239	180	265	310	475	-	165	595	225	575	525	185	22	4 x 20	25	125
225	225	575	445	250	267	203	280	340	530	-	185	660	250	635	580	205	22	4 x 20	30	130
250	250	630	480	280	298	215	300	370	600	-	210	740	280	695	635	220	26	4 x 24	30	140
280	280	715	520	315	327	237	335	410	670	-	240	820	315	785	720	240	26	4 x 24	35	160
315	315	800	560	355	350	256	375	450	750	-	270	920	355	875	805	260	33	4 x 30	40	180
355	355	870	630	400	405	286	425	500	865	530	305	1055	400	950	875	290	33	6 x 30	50	200
400	400	990	700	450	456	320	475	560	1000	600	350	1200	450	1075	995	325	39	6 x 36	55	220
450	450	1100	780	500	497	360	530	640	1120	670	395	1330	500	1190	1105	365	39	6 x 36	60	250

Unit Size				INPUT SHAFTS						OUTPUT SHAFTS					
	U1	V3	V6	V	V4	W	W2	Y	Z	V1	V5	W1	W3	Y1	Z1
140	60	230	105	28.009 27.996	M8 x 20	60	53	7.985 7.949	24.0 23.8	70.030 70.011	M24 x 52	140	130	19.978 19.926	62.5 62.3
160	70	263	125	32.018 32.002	M8 x 20	80	73	9.985 9.949	27.0 26.8	75.030 75.011	M24 x 52	140	130	19.978 19.926	67.5 67.3
180	85	295	145	38.018 38.002	M16 x 36	80	73	9.985 9.949	33.0 32.8	85.035 85.013	M24 x 52	170	160	21.978 21.926	76.0 75.8
200	90	305	140	45.018 45.002	M16 x 32	110	102	13.982 13.939	39.5 39.3	90.035 90.013	M24 x 50	170	160	24.978 24.926	81.0 80.8
225	95	356	171	50.018 50.002	M16 x 32	110	102	13.982 13.939	44.5 44.3	100.035 100.013	M24 x 50	210	200	27.978 27.926	90.0 89.8
250	115	402	190	55.030 55.011	M24 x 50	110	102	15.982 15.939	49.0 48.8	110.035 110.013	M30 x 60	210	200	27.978 27.926	100.0 99.8
280	125	450	225	65.030 65.011	M24 x 50	140	130	17.982 17.939	58.0 57.8	125.040 125.015	M30 x 60	210	200	31.974 31.912	114.0 113.8
315	130	480	230	75.030 75.011	M24 x 50	140	130	19.978 19.926	67.5 67.3	140.040 140.015	M30 x 60	250	240	35.974 35.912	128.0 127.7
355	155	540	270	85.035 85.013	M24 x 50	170	160	21.978 21.926	76.0 75.8	160.040 160.015	M24 x 80	300	290	39.974 39.912	147.0 146.7
400	175	610	300	90.035 90.013	M24 x 50	170	160	24.978 24.926	81.0 80.8	180.040 180.015	M42 x 80	300	290	44.974 44.912	165.0 164.7
450	195	650	320	100.035 100.013	M24 x 50	210	200	27.978 27.926	90.0 89.8	200.046 200.017	M42 x 80	350	340	44.974 44.912	185.0 184.7

The second phase of the project:

Gearbox design

ideal case : $H_{in} = H_{out} \rightarrow T\omega_{in} = T\omega_{out}$

$$e = \frac{\omega_{in}}{\omega_{out}} = \frac{T_{out}}{T_{in}}$$

$$e = \frac{\omega_{in}}{\omega_{out}} = \frac{\omega_{shaft\ 1}}{\omega_{shaft\ 2}} \times \frac{\omega_{shaft\ 2}}{\omega_{shaft\ 3}} = \frac{\omega_{gear\ 1}}{\omega_{gear\ 2}} \times \frac{\omega_{gear\ 3}}{\omega_{gear\ 4}} = \frac{N_{gear\ 2}}{N_{gear\ 1}} \times \frac{N_{gear\ 4}}{N_{gear\ 3}}$$

For smallest package size, let both stages be the same reduction:

$$\frac{N_{gear\ 2}}{N_{gear\ 1}} = \frac{N_{gear\ 4}}{N_{gear\ 3}} = \sqrt{15.4}$$

For this ratio, the minimum number of teeth for helical gear:

$$N_p = \frac{2k\cos\psi}{(1+2m)(\sin^2\varphi_t)}\left(m + \sqrt{m^2 + (1+2m)\sin^2\varphi_t}\right)$$

$$m = \frac{1}{\sqrt{15.4}}$$

full depth $\rightarrow k = 1$

$\varphi_t = 20°$

$\psi = 30°$

$$\rightarrow N_p = \frac{2\cos 30°}{\left(1+\frac{2}{\sqrt{15.4}}\right)(\sin^2 20°)}\left(\frac{1}{\sqrt{15.4}} + \sqrt{\frac{1}{15.4} + \left(1+\frac{2}{\sqrt{15.4}}\right)\sin^2 20°}\right)$$

$\rightarrow N_p = 7.32 \rightarrow N_{3_{min}} = 8\ teeth$

$\rightarrow N_g = N_p\sqrt{15.4} = 8\sqrt{15.4} = 31.39 \rightarrow N_{4_{min}} = 31\ teeth$

For this ratio, the minimum number of teeth for bevel gear:

$$N_p = \frac{2k}{3\sin^2\varphi}\left(1+\sqrt{3\sin^2\varphi}\right) = \frac{2}{3\sin^2 20°}\left(1+\sqrt{3\sin^2 20°}\right) = 11.72$$

30210 for both of 2 bearings

C=93.1 kn $C_0 = 91.5\ kn$ $e = 0.35$ Y=1.7

$\frac{F_{ra}}{Y_a} > \frac{F_{rb}}{Y_b}$ *correct*

K>0.5$(\frac{F_{ra}-F_{rb}}{Y})$

18.302>1.832 correct

$$F_{ab} = \frac{0.5F_{rb}}{Y} = 3.955\ kn$$

$F_{aA} = F_{ab} + K = 22.257\ kn$

Bearing A

$\frac{F_{aA}}{F_{rA}} = 1.13 > e$

P=0.4$F_{rA} + YF_{aA}$ = 45.7 kn

C=pL^0.3 =275.7>C ✕

Trial 2

32310 for both of 2 bearings

C=211 kn

$C_0 = 212\ kn$

e =0.88 for $d_1 = 81.3$ *from SKF*

Y=0.68

$\frac{F_{ra}}{Y_a} > \frac{F_{rb}}{Y_b}$ *correct*

K>0.5$(\frac{F_{ra}-F_{rb}}{Y})$

18.302>4.58 kn

$$F_{ab} = \frac{0.5F_{rb}}{Y} = 9.88\ kn$$

$F_{aA} = F_{ab} + K = 28.19\ kn$

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Bearing A

$\frac{F_{aA}}{F_{rA}} = 1.4 > e$

P=0.4$F_{rA} + YF_{aA}$ = 27.04 *kn*

C=PL^0.3=165<C correct

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