

Engineering Design Case Studies

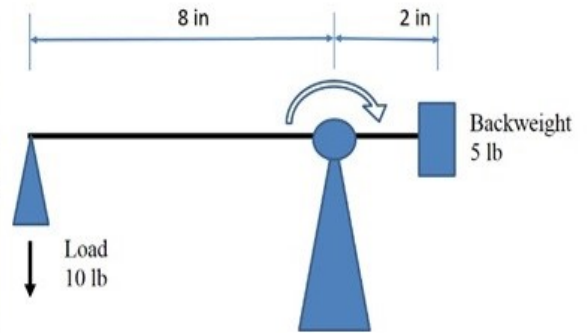
1. Counter weights are commonly used in different applications such as robots and cranes. In the robotic arm below, what is the torque that is needed by the motor to balance the 10 lb load? (2 pts)



Crane



Robotics



Robotic Arm

Applications of counter weights in the design of mechanical systems

2. Design of a Belt Power Drive System

Design a belt drive system for the following application:

The belt drive will be used in a textile machinery, powered by a NEMA design B induction motor of 50 hp and operating 12 hours per day. The motor has a full-load speed of 1750 rpm. The output sheave should have a speed of about 1,000 rpm. Use the charts on pages 3 and 4.

Step 1. Find the recommended service factor for this application:

Motor service factor = _____

Step 2. Calculate the design Power.

Design Power = _____

Step 3. Select the belt section from the BesTorq belt chart shown in Figure 1 for the given input speed.

Recommended Belt section : _____

Step 4. Calculate the speed ratio of the belt drive

Speed Ratio = _____

Step 5. Calculate the diameter of the driving sheave that would result in the recommended belt speed of 4000 ft/min:

Belt speed = 4000 ft/min = 0.262 x D[inch] x rpm

Din = _____ Closest standard diameter = _____ (find from chart)

Step 6. Calculate the diameter of the driven sheave:

$D_{out} =$ _____

Closest standard diameter = _____

Step 7. Use the chart to determine the rated power per belt for the diameter of the small sheave.

Rated Power per belt: _____

Step 8. Determine the number of belts required for this application:

Number of belts required: _____

Step 9. Calculate the range for an acceptable center distance, and choose a center distance that keeps the system as compact as possible.

Note: Recommended range of the Center Distance (C) = $D_{out} < C < 3 (D_{in} + D_{out})$

Center distance range: _____

Chosen center distance = _____

Step 10. Calculate the belt length: _____

$$Belt\ Length \approx 2C + \frac{\pi}{2}(D_{in} + D_{out})$$

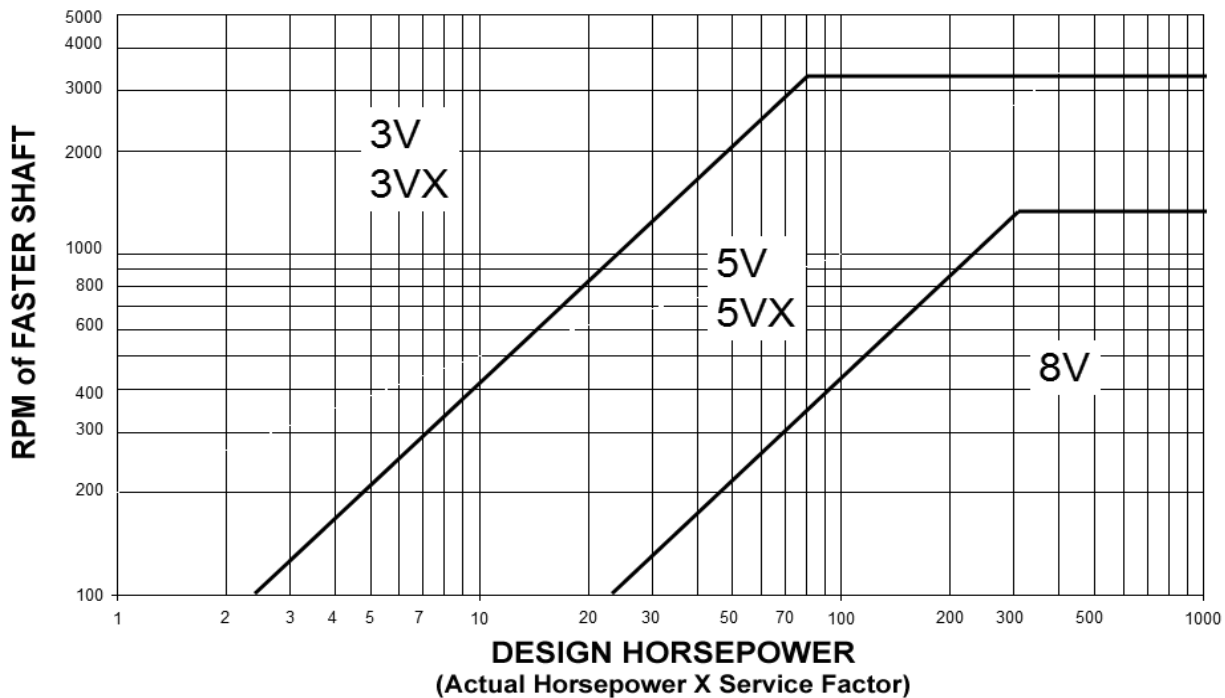


Figure 1. Chart Source: BesTorq Belt Selection catalog: <https://www.bestorq.com/crosssection.asp>

STANDARD 5V TRANSMISSION HORSEPOWER RATINGS

HP RATINGS PER BELT FOR SMALL SHEAVE OD (IN)

Table 9

RPM	7.1	7.5	8.0	8.5	9.0	9.25	9.75	10.3	10.9	11.8	12.5	13.2	14.0	15.0	16.0
485	6.38	7.00	7.72	8.49	9.25	9.76	10.54	11.30	12.29	13.52	14.61	15.73	16.85	18.31	19.71
575	7.20	7.93	8.77	9.67	10.55	11.14	12.06	12.95	14.10	15.51	16.79	18.10	19.39	21.06	22.68
690	8.41	9.27	10.26	11.32	12.35	13.05	14.13	15.17	16.52	18.17	19.66	21.18	22.68	24.62	26.49
725	8.77	9.68	10.70	11.79	12.90	13.61	14.74	15.84	17.23	18.95	20.51	22.09	23.65	25.67	27.61
870	10.22	11.28	12.49	13.77	15.06	15.89	17.21	18.48	20.11	22.12	23.90	25.71	27.51	29.81	32.03
950	11.00	12.14	13.44	14.83	16.21	17.11	18.52	19.90	21.63	23.79	25.68	27.61	29.53	31.97	34.31
1160	12.93	14.29	15.83	17.46	19.08	20.14	21.79	23.39	25.40	27.94	30.06	32.21	34.39	37.11	39.71
1425	15.19	16.79	18.59	20.50	22.39	23.62	25.51	27.35	29.62	32.59	34.87	37.22	39.57	42.44	45.18
1750	17.66	19.52	21.60	23.79	25.95	27.32	29.43	31.48	33.94	37.34	39.55	41.81	44.22	46.93	49.49
2850	23.25	25.54	28.06	30.58	32.91	34.14	36.05	37.96							
3450	24.11	26.29	28.63	30.80											
50	0.83	0.90	0.99	1.08	1.18	1.24	1.33	1.43	1.55	1.71	1.84	1.97	2.11	2.28	2.47
60	0.98	1.06	1.17	1.28	1.40	1.45	1.58	1.69	1.83	2.01	2.16	2.33	2.50	2.71	2.91
70	1.11	1.22	1.35	1.47	1.60	1.68	1.81	1.94	2.11	2.32	2.50	2.68	2.87	3.12	3.36
80	1.26	1.38	1.51	1.67	1.81	1.90	2.04	2.20	2.39	2.62	2.82	3.04	3.25	3.53	3.80
90	1.41	1.53	1.69	1.84	2.01	2.11	2.28	2.44	2.65	2.92	3.15	3.38	3.63	3.94	4.24
100	1.54	1.69	1.85	2.03	2.22	2.32	2.51	2.68	2.92	3.21	3.46	3.73	3.99	4.34	4.67
150	2.22	2.43	2.67	2.94	3.19	3.36	3.63	3.88	4.23	4.65	5.01	5.41	5.79	6.29	6.78
200	2.86	3.13	3.46	3.80	4.13	4.35	4.70	5.04	5.49	6.04	6.53	7.02	7.53	8.19	8.81
250	3.48	3.82	4.21	4.63	5.05	5.32	5.75	6.16	6.71	7.38	7.99	8.61	9.22	10.03	10.80
300	4.10	4.49	4.96	5.45	5.94	6.26	6.77	7.27	7.91	8.70	9.42	10.14	10.88	11.83	12.73
350	4.69	5.15	5.68	6.25	6.81	7.19	7.77	8.35	9.08	9.99	10.81	11.66	12.49	13.59	14.64
400	5.26	5.78	6.39	7.03	7.67	8.09	8.75	9.40	10.23	11.26	12.19	13.13	14.07	15.31	16.49
450	5.83	6.41	7.08	7.79	8.51	8.98	9.72	10.44	11.36	12.50	13.52	14.58	15.63	16.99	18.30
500	6.38	7.03	7.76	8.56	9.34	9.85	10.66	11.45	12.47	13.72	14.85	16.01	17.15	18.64	20.09
550	6.93	7.63	8.43	9.30	10.15	10.72	11.59	12.46	13.56	14.92	16.15	17.41	18.65	20.27	21.82
600	7.47	8.23	9.10	10.02	10.94	11.56	12.51	13.45	14.63	16.10	17.43	18.77	20.11	21.85	23.52
650	7.99	8.82	9.75	10.74	11.74	12.40	13.41	14.41	15.69	17.26	18.67	20.12	21.55	23.41	25.20
700	8.51	9.38	10.38	11.45	12.52	13.21	14.30	15.36	16.73	18.40	19.90	21.44	22.96	24.92	26.82
750	9.03	9.96	11.02	12.15	13.27	14.01	15.18	16.29	17.75	19.52	21.10	22.72	24.33	26.41	28.40
800	9.54	10.51	11.63	12.83	14.02	14.81	16.03	17.22	18.74	20.62	22.29	23.99	25.67	27.85	29.94
850	10.03	11.06	12.24	13.51	14.76	15.59	16.88	18.13	19.72	21.69	23.44	25.22	26.99	29.26	31.43
900	10.52	11.60	12.84	14.17	15.49	16.36	17.71	19.02	20.69	22.76	24.58	26.42	28.28	30.63	32.89
950	11.00	12.14	13.44	14.83	16.21	17.11	18.52	19.90	21.63	23.79	25.68	27.61	29.53	31.97	34.31
1000	11.47	12.66	14.01	15.47	16.91	17.86	19.32	20.75	22.56	24.82	26.78	28.75	30.74	33.26	35.67

Source: <https://www.bandousa.com/html/pdfs/bu-143manual.pdf>