

Mechanical Analysis and Design ME 2104

Lecture 3

Mechanical Analysis Belt and chain drives

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Plan for the analysis of mechanical elements

Objective:

Procedures for design and selection of mechanical elements

- Week 1 Shafts and keyways
- Week 2 Bearings and screws
- Week 3 Belt and chain drives
 - Week 4 Gears and gear trains
 - Week 5 Design Project Review



Plan for this week

- Flexible mechanical elements introduction
- Flat and round belts (with examples)
- V belts (with examples)
- Chains (with examples)





Overview – why use?

- 1. Transfer power (torque) from one location to another. From driver: motor, peddles, engine, windmill, turbine To driven: conveyor belt, back wheels/ bike, generator rock crusher, dryer.
- 2. Used to span large distances or need flexible x-mission elements. Gear drives have a higher torque capability but are not this flexible or cheap.
- Often used as torque increaser
 (speed reducer), max speed ratio:3.5:1.
 Gear drives?? Virtually unlimited!

Applications?





Belt or C	Chain?			
Whať	s Best?	Belt drives	Chain drives	Gear drives
	Use for	High speed Low torque	Low speed High torque	High speed High torque
	Speed	12 – 40 m/s	Up to 10 m/s	Depending on the type of gear
	Disadvantage	Standard lengths Wear, creep, slip, temperature, may require idler	Must be lubricated, wear, noise, vibrations	Expensive, Not flexible, Needs lubrication and cooling
5	Advantage	Quiet, flexible, cheap, can be used to dump vibrations	Strength, length, flexibility	High speed, strength, durability



Types of Belts:

Belt Type	Figure	Joint	Size Range	Center Distance
Flat	t t	Yes	$t = \begin{cases} 0.03 \text{ to } 0.20 \text{ in} \\ 0.75 \text{ to } 5 \text{ mm} \end{cases}$	No upper limit
Round	$O_{\frac{d}{\uparrow}}$	Yes	$d = \frac{1}{8}$ to $\frac{3}{4}$ in	No upper limit
V		None	$b = \begin{cases} 0.31 \text{ to } 0.91 \text{ in} \\ 8 \text{ to } 19 \text{ mm} \end{cases}$	Limited
Timing		None	p = 2 mm and up	Limited



Types of V-Belts







 $L = \sqrt{4C^2 - (D+d)^2} + \frac{1}{2}(D+d)\theta$

(b)



V-belt Drive Design Process

- 1. Rated power of the driving motor/prime mover.
- 2. Service factor based on type of driver and driven load.
- 3. Center distance (adjustment for center distance must be provided or use idler pulley)
- 4. Power rating for one belt as a function of size and speed of the smaller pulley
- 5. Belt length (then choose standard size)
- Sizing of sheaves/pulleys (use standard size). Most commercially available sheaves should be limited to 35 m/s belt speed.
- 7. Belt length correction factor
- 8. Angle of wrap correction factor. Angle of wrap on smaller sheave should be greater than 120 deg.
- 9. Number of belts
- 10. Initial tension in belts



Key Equations

	Belt speed (no slip) [m/s]	$\upsilon_b = R_D \omega_D = R_d \omega_d = \frac{D\omega_D}{2} = \frac{d\omega_d}{2}$
Recommended:	Speed ratio	$\frac{\omega_D}{\omega_L} = \frac{D}{d}$ $\upsilon_b = \pi D n_D$
D < C < 3(D+d)		ω_d ω
Use standard lengths	Belt length [m]	$L = 2C + \frac{\pi}{2}(D+d) + \frac{(D-d)^2}{4C}$
sin	Centre distance [m]	$C = \frac{B + \sqrt{B^2 - 32(D - d)^2}}{16}$
$\frac{1}{2}\sqrt{4C^2 - (D-d)^2}$		$B = 4L - 2\pi(D - d)$
$\sin^{-1}\frac{D-d}{2C}$		$\theta_1 = \pi - 2\sin^{-1} \left[\frac{D - d}{2C} \right]$
		$\theta_2 = \pi + 2\sin^{-1} \left[\frac{D-d}{2C} \right]$
∢ C		Ahmed Kovacevic, City University London



Forces





Example 7 – V Belt Design

A four cylinder Diesel engine runs @ 80hp, 1800 rpm to drive a water pump (1200 rpm) for less than 6 hours/day

Design a V-belt drive





V-Belt Design Example

4 cylinder Diesel engine runs @ 80hp, 1800 rpm to drive a water pump (1200 rpm) for less than 6 hours/day

Design V-belt drive

D=315mm; d=212 mm; C=1.0975m; L=2.338 m; 4 belts



Design Example







Belt Designation

	1 	0→ ↓ ↓		<u>←</u> 13- ******							
Belt Des	ignation	Belt Des	ignation	Belt Des	ignation		Belt Des	ignation		Belt Des	ignation
	SF	PZ		SP	A	5	SPB	U	SPB	SPC	USPC
Metric	Imperial 3V	Metric	Imperial 3V			Metric	Imperial 5V	Metric	Imperial 5V		
487	-	1400	-	732	1750	1250	-	1600	630	2000	2650
512	-	1412	-	757	1757	1260	5V 500	1800	710	2120	2800
562	-	1420	560	782	1782	1320	-	1900	-	2240	3000
587	-	1437	-	800	1800	1340	530	2000	-	2360	3150
612	-	1462	-	807	1807	1400	-	2120	-	2500	3350
630	3V 250	1470	580	825	1832	1410	560	2240	-	2650	3550
637	-	1487	-	832	1850	1500	-	2360	-	2800	3750
662	-	1500	-	850	1857	1550	-	2500	-	3000	4000
670	-	1512	-	857	1882	1600	630	2650	-	3150	4250
687	-	1520	600	875	1900	1670	-	2800	-	3350	4500
710	280	1537	-	882	1907	1700	-	3000	1180	3550	4750
722	-	1560	617	900	1932	1750	-	3150	-	3750	5000
737	-	1587	-	907	1950	1800	710	3350	-	4000	5300
750	-	1600	630	925	1957	1850	-	3550	-	4250	5600
760	300	1612	-	932	1982	1900	-	3750	1500	4500	6000
772	-	1637	-	950	2000	1950	-	4000	-	4750	6300
787		1650	650	957	2032	1980	-	4060	1600	5000	6700
800	315	1662	-	975	2057	2000	-	4250	-	5300	7100
812	-	1687	-	982	2060	2020	800	4310	1700	5600	7500
825	-	1700	670	1000	2082	2060	-	4500	-	6000	8000
837	-	1737	-	1007	2120	2120	-	4750	-	6300	8500
850		1762	-	1030	2132	2150	850	5000	-	6700	9000
862	-	1787	-	1060	2180	2240		5300	-	7100	9500
875	-	1800	710	1082	2207	2280	900	5600	-	7500	
887	-	1812	-	1090	2232	2360		6000	2360	8000	
900	355	1837	-	1107	2240	2410	950	6300	-	8500	
912	-	1850	730	1120	2282	2450	-	6700	-	9000	



Service factors

		Types of Prime Mover									
	SPEED INCREASE RATIO		'Soft' Starts			'Heavy' Series					
For speed incre Speed ratio 1.00 Speed ratio 1.29 Speed ratio 1.79 Speed ratio 2.5 Speed ratio 3.5	asing drives of: 0 – 1.24 multiply service factor by 1.00 5 – 1.74 multiply service factor by 1.05 5 – 2.49 multiply service factor by 1.11 0 – 3.49 multiply service factor by 1.18 0 and over multiply service factor by 1.25	Electric motors: AC - Star Del: DC - Shunt w Internal combus cylinders Prime movers fit or fluid coupling	lectric motors: AC - Star Delta start DC - Shunt wound nternal combustion engines with 4 or more ylinders 'rime movers fitted with centrifugal clutches, dry or fluid couplings or electronic soft start devices Electric motors: AC - Direct-on-line start DC - Series and component Internal combustion engines w cylinders Prime movers not fitted with se								
	TYPES OF DRIVEN MACHINE			Hours	per day						
		10 and under	Over 10 to 16	Over 16	10 and under	Over 10 to 16	Over 16				
Class 1 Light Duty	Agitators (uniform density), blowers, exhausters and fans up to 7.5kW, centrifugal compressors and pumps. Belt conveyors (uniformly loaded).	1.0	1.1	1.2	1.1	1.2	1.3				
Class 2 Medium Duty	Agitators and mixers (variable density), blowers, exhausters an fans (over 7.5kW). Rotary compressors and pumps (other than centrifugal). Belt conveyors (not uniformly loaded), generators and excitors, laundry machinery, lineshafts, machine tools, printing machinery, sawmill and woodworking machinery, screens (rotary)	1.1	1.2	1.3	1.2	1.3	1.4				
Class 3 Heavy Duty	Brick machinery, bucket elevators, compressors and pumps (reciprocating), conveyors (heavy duty). Hoists, mills (hammer), pulverisers, punches, presses, shears, quarry plant, rubber machinery, screens (vibrating), textile machinery.	1.2	1.3	1.4	1.4	1.5	1.6				
Class 4 Extra Heavy Duty	Crushers (gyratory-jaw roll), mills (ball-rod-tube)	1.3	1.4	1.5	1.5	1.6	1.8				



Power rating for SPB V-belts

Rev/min		-		R	ated Powe	r (kW) Per I	Belt for Sma	all Pulley P	itch Dia (m	m)				Belt
shaft	140	150	160	170	180	190	200	212	224	236	250	280	315	m/s
100	0.74	0.82	0.93	1.02	1.12	1.20	1.30	1.42	1.53	1.63	1.77	2.04	2.36	
200	1.36	1.51	1.73	1.89	2.08	2.24	2.44	2.65	2.86	3.08	3.32	3.84	4.44	
300	1.91	2.14	2.44	2.67	2.96	3.18	3.47	3.80	4.08	4.42	4.73	5.48	6.34	
400	2.44	2.74	3.12	3.43	3.79	4.10	4.45	4.87	5.24	5.65	6.09	7.05	8.16	10
500	3.02	3.39	3.86	4.24	4.70	5.06	5.52	6.09	6.51	7.11	7.56	8.76	10.15	
600	3.51	3.98	4.51	4.97	5.49	5.96	6.47	7.09	7.62	8.22	8.79	10.19	11.78	
700	4.01	4.56	5.16	5.69	6.29	6.86	7.41	8.09	8.74	9.32	10.16	11.77	13.62	
720	4.11	4.67	5.28	5.84	6.45	7.02	7.59	8.30	8.96	9.57	10.41	12.06	13.95	
800	4.48	5.12	5.78	6.44	7.06	7.67	8.32	9.13	9.81	10.56	11.40	13.20	15.26	
900	4.91	5.55	6.34	7.00	7.75	8.45	9.14	9.96	10.78	11.57	12.52	14.49	16.73	20
960	5.17	5.80	6.68	7.33	8.17	8.91	9.63	10.45	11.36	12.18	13.19	15.26	17.61	20
1000	5.35	6.03	6.92	7.63	8.46	9.22	9.97	10.83	11.76	12.62	13.66	15.79	18.20	
1100	5.80	6.61	7.51	8.37	9.18	10.00	10.83	11.79	12.77	13.71	14.82	17.11	19.69	
1200	6.25	7.18	8.10	9.11	9.91	10.77	11.69	12.75	13.78	14.80	15.98	18.43	21.18	
1300	6.65	7.66	8.62	9.65	10.56	11.53	12.45	13.56	14.66	15.72	16.98	19.56	22.42	
1400	7.05	8.13	9.15	10.19	11.21	12.29	13.21	14.37	15.55	16.65	17.99	20.69	23.66	
1450	7.25	8.37	9.41	10.46	11.53	12.67	13.59	14.78	15.99	17.11	18.50	21.26	24.29	30
1500	7.43	8.58	9.66	10.76	11.83	12.95	13.95	15.18	16.40	17.56	18.95	21.76	24.82	00
1600	7.81	9.01	10.16	11.36	12.44	13.50	14.65	15.99	17.22	18.46	19.87	22.77	25.90	
1700	8.16	9.42	10.62	11.86	13.01	14.15	15.31	16.69	17.97	19.25	20.70	23.66	26.82	
1800	8.52	9.82	11.09	12.35	13.58	14.79	15.97	17.39	18.72	20.03	21.53	24.55	27.73	
1900	8.85	10.21	11.52	12.84	14.10	15.37	16.57	18.01	19.40	20.73	22.26	25.30	28.45	
2000	9.18	10.60	11.96	13.33	14.62	15.94	17.17	18.63	20.07	21.43	22.99	26.05	29.17	
2200	9.75	11.24	12.70	14.14	15.50	16.87	18.15	19.61	21.11	22.45	24.03	26.98	29.82	40
2400	10.31	11.89	13.43	14.95	16.38	17.80	19.13	20.60	22.16	23.48	25.07	27.92	30.47	40
2500	10.60	12.21	13.80	15.35	16.81	18.26	19.62	21.09	22.68	23.99	25.59	28.38	30.80	
2600	10.82	12.48	14.09	15.63	17.14	18.57	19.95	21.42	22.99	24.34	25.83	28.46		
2700	11.05	12.75	14.37	15.92	17.46	18.87	20.29	21.74	23.31	24.70	26.07	28.54		
2800	11.27	13.02	14.66	16.20	17.79	19.18	20.63	22.07	23.62	25.05	26.31	28.62		
2850	11.38	13.15	14.80	16.34	17.95	19.33	20.79	22.23	23.78	25.23	26.43	28.66		



Additional speed power ratio

Rev/min of	Additional Power (kW) per belt for speed ratio											
faster shaft	1.00 to 1.01	1.02 to 1.05	1.06 to 1.11	1.12 to 1.18	1.19 to 1.26	1.27 to 1.38	1.30 to 1.57	1.58 to 1.94	1.95 to 3.38	3.39 and over		
100	0.00	0.01	0.02	0.04	0.04	0.06	0.07	0.07	0.08	0.08		
200	0.00	0.01	0.04	0.07	0.09	0.11	0.13	0.15	0.16	0.17		
300	0.00	0.02	0.06	0.10	0.14	0.17	0.20	0.22	0.24	0.25		
400	0.00	0.03	0.07	0.13	0.19	0.22	0.26	0.29	0.32	0.34		
500	0.00	0.04	0.09	0.17	0.23	0.28	0.33	0.37	0.40	0.43		
600	0.00	0.04	0.12	0.20	0.28	0.34	0.40	0.45	0.48	0.51		
700	0.00	0.05	0.13	0.24	0.33	0.39	0.46	0.52	0.57	0.59		
720	0.00	0.05	0.14	0.25	0.33	0.41	0.48	0.54	0.59	0.62		
800	0.00	0.06	0.16	0.28	0.37	0.45	0.53	0.60	0.65	0.69		
900	0.00	0.07	0.18	0.31	0.42	0.51	0.60	0.66	0.72	0.77		
960	0.00	0.07	0.19	0.32	0.44	0.54	0.62	0.70	0.77	0.81		
1000	0.00	0.07	0.19	0.34	0.46	0.56	0.66	0.74	0.81	0.86		
1100	0.00	0.08	0.22	0.37	0.51	0.62	0.72	0.81	0.89	0.94		
1200	0.00	0.09	0.23	0.41	0.56	0.68	0.79	0.89	0.97	1.03		
1300	0.00	0.09	0.25	0.44	0.60	0.73	0.86	0.96	1.05	1.11		
1400	0.00	0.10	0.28	0.48	0.65	0.79	0.93	1.04	1.13	1.20		
1440	0.00	0.10	0.28	0.48	0.66	0.79	0.94	1.06	1.15	1.21		
1500	0.00	0.10	0.29	0.51	0.69	0.84	0.99	1.11	1.21	1.28		
1600	0.00	0.11	0.31	0.54	0.75	0.90	1.05	1.19	1.29	1.37		
1700	0.00	0.12	0.34	0.58	0.79	0.95	1.12	1.26	1.37	1.45		
1800	0.00	0.13	0.35	0.61	0.84	1.01	1.19	1.34	1.45	1.54		
1900	0.00	0.13	0.37	0.65	0.88	1.07	1.25	1.41	1.54	1.63		
2000	0.00	0.14	0.39	0.68	0.93	1.13	1.32	1.48	1.62	1.71		
2100	0.00	0.15	0.41	0.72	0.98	1.18	1.39	1.56	1.69	1.79		
2200	0.00	0.16	0.43	0.75	1.02	1.24	1.45	1.63	1.78	1.88		
2300	0.00	0.16	0.45	0.78	1.07	1.29	1.51	1.71	1.86	1.97		
2400	0.00	0.17	0.47	0.82	1.11	1.35	1.58	1.78	1.94	2.05		
2500	0.00	0.18	0.49	0.85	1.16	1.41	1.65	1.86	2.02	2.14		
2600	0.00	0.19	0.51	0.89	1.21	1.46	1.72	1.92	2.10	2.22		
2700	0.00	0.19	0.53	0.92	1.25	1.52	1.78	1.99	2.18	2.31		
2800	0.00	0.20	0.54	0.95	1.29	1.57	1.84	2.07	2.26	2.39		
2880	0.00	0.20	0.56	0.97	1.32	1.60	1.88	2.11	2.31	2.44		
2900	0.00	0.21	0.57	0.99	1.34	1.63	1.91	2.15	2.34	2.48		
3000	0.00	0.22	0.59	1.02	1.39	1.69	1.98	2.23	2.42	2.57		



Correction factors



Figure 13–14 Angle of Wrap Correction Factor, C₀



Figure 13–15 Belt Length Correction Factor, CL



Example 8 – Flat Belt Design

A flat belt is 152.4 mm wide and 8.5 mm thick and transmits 15 hp.

The centre distance is 2.424 m. The driving pulley is 152.4 mm in diameter and rotates at 2000 rpm such that the loose side of the belt is on top. The driven pulley is 457.2 mm in diameter. The belt material specific density is 996.5 kg/m³

Determine:

- a) If friction coef. is f=0.3 find F_1 and F_2 .
- b) If f is reduced to 0.2 due to oil spill, what are F_1 and F_2 ? Would the belt slip?
- c) What is the belt length?



a) F₁=1500 N ; F₂= 800 N ; F_i=1150N
b) The belt will slip
c) L=5.8445 m



Chain Drives





Chain Drives

Types of Chains

Main dimensions



ROLLER LINK



SROWNING CON

SPRING CLIP CONNECTING LINK



COTTER PIN CONNECTING LINK







P – pitch γ – pitch angle $\gamma/2$ – angle of articulation D – pitch diameter e – cordial rise (factor for smoothness)

$$D = \frac{p}{\sin(\gamma/2)} = \frac{p}{\sin(\pi/N)}$$

$$v = Npn/60$$

$$\frac{L}{p} = 2\left(\frac{C}{p}\right) + \frac{N_1 + N_2}{2} + \frac{\left(N_1 - N_1\right)^2}{4\pi^2 \left(\frac{C}{p}\right)}$$

$$30 < \left(\frac{C}{p}\right) < 50$$

p

L – chain length v – chain speed N – number of teeth in the sprocket n – [rpm]



Chain Design Process

- # of sprocket teeth, N1 (smaller sprocket) > 17 (unless low speed < 100 rpm.)
- 2. Speed ratio = $n1/n2 \le 7$
- 30 x Pitch Length < Center Distance < 50 x Pitch Length
- 4. Angle of contact of chain on smaller sprocket > 120°
- 5. # sprocket teeth, N2 (larger sprocket) < 120



Standard size and strength of rolling chain

ANSI Chain Number	Pitch, in (mm)	Width, in (mm)	Minimum Tensile Strength, Ibf (N)	Average Weight, Ibf/ft (N/m)	Roller Diameter, in (mm)	Multiple- Strand Spacing, in (mm)
25	0.250	0.125	780	0.09	0.130	0.252
	(6.35)	(3.18)	(3 470)	(1.31)	(3.30)	(6.40)
35	0.375	0.188	1 760	0.21	0.200	0.399
	(9.52)	(4.76)	(7 830)	(3.06)	(5.08)	(10.13)
41	0.500 (12.70)	0.25 (6.35)	1 500 (6 670)	0.25 (3.65)	0.306 (7.77)	_
40	0.500	0.312	3 130	0.42	0.312	0.566
	(12.70)	(7.94)	(13 920)	(6.13)	(7.92)	(14.38)
50	0.625	0.375	4 880	0.69	0.400	0.713
	(15.88)	(9.52)	(21 700)	(10.1)	(10.16)	(18.11)
60	0.750	0.500	7 030	1.00	0.469	0.897
	(19.05)	(12.7)	(31 300)	(14.6)	(11.91)	(22.78)
80	1.000	0.625	12 500	1.71	0.625	1.153
	(25.40)	(15.88)	(55 600)	(25.0)	(15.87)	(29.29)
100	1.250	0.750	19 500	2.58	0.750	1.409
	(31.75)	(19.05)	(86 700)	(37.7)	(19.05)	(35.76)
120	1.500	1.000	28 000	3.87	0.875	1.789
	(38.10)	(25.40)	(124 500)	(56.5)	(22.22)	(45.44)
140	1.750	1.000	38 000	4.95	1.000	1.924
	(44.45)	(25.40)	(169 000)	(72.2)	(25.40)	(48.87)
160	2.000	1.250	50 000	6.61	1.125	2.305
	(50.80)	(31.75)	(222 000)	(96.5)	(28.57)	(58.55)
180	2.250	1.406	63 000	9.06	1.406	2.592
	(57.15)	(35.71)	(280 000)	(132.2)	(35.71)	(65.84)
200	2.500	1.500	78 000	10.96	1.562	2.817
	(63.50)	(38.10)	(347 000)	(159.9)	(39.67)	(71.55)
240	3.00	1.875	112 000	16.4	1.875	3.458
	(76.70)	(47.63)	(498 000)	(239)	(47.62)	(87.83)



Transmitted power of a single strand no 25 chain

									Small	sprocket	speed, rp	m								
Number of teeth in	100	500	900	1200	1800	2500	3000	3500	4000	4500	5000	5500	6000	6500	7000	7500	8000	8500	9000	10 000
small sprocket		Ту	pe 1									Type II lu	brication							
11	0.054	0.23	0.39	0.50	0.73	0.98	1.15	1.32	1.42	1.19	1.01	0.88	0.77	0.68	0.61	0.55	0.50	0.46	0.42	0.36
12	0.059	0.25	0.43	0.55	0.80	1.07	1.26	1.45	1.62	1.36	1.16	1.00	0.88	0.78	0.70	0.63	0.57	0.52	0.48	0.41
13	0.064	0.27	0.47	0.60	0.87	1.17	1.38	1.58	1.78	1.53	1.30	1.13	0.99	0.88	0.79	0.71	0.64	0.59	0.54	0.46
14	0.070	0.30	0.50	0.65	0.94	1.27	1.49	1.71	1.93	1.71	1.46	1.26	1.11	0.94	0.88	0.79	0.72	0.66	0.60	0.51
15	0.075	0.32	0.54	0.70	1.01	1.36	1.61	1.85	2.06	1.89	1.62	1.40	1.23	1.09	0.96	0.88	0.80	0.73	0.67	0.57
16	0.081	0.34	0.58	0.75	1.09	1.46	1.72	1.88	2.23	2.08	1.78	1.54	1.35	1.20	1.07	0.97	0.88	0.80	0.74	0.63
17	0.086	0.37	0.62	0.81	1.16	1.56	1.84	2.11	2.38	2.28	1.95	1.69	1.48	1.31	1.18	1.06	0.96	0.88	0.81	0.69
18	0.097	0.39	0.66	0.86	1.23	1.66	1.85	2.25	2.53	2.49	2.12	1.84	1.52	1.43	1.28	1.16	1.05	0.96	0.88	0.75
19	0.097	0.41	0.70	0.91	1.31	1.76	2.07	2.38	2.69	2.70	2.30	2.00	1.75	1.55	1.39	1.25	1.14	1.04	0.96	0.81
20	0.103	0.44	0.74	0.96	1.38	1.86	2.19	2.52	2.84	2.91	2.49	2.16	1.89	1.68	1.50	1.35	1.23	1.12	1.03	0.88
21	0.108	0.46	0.78	1.01	1.46	1.96	2.31	2.65	2.99	3.13	2.68	2.32	2.04	1.80	1.61	1.46	1.32	1.21	1.11	0.95
22	0.114	0.48	0.82	1.06	1.53	2.06	2.43	2.79	3.15	3.36	2.87	2,49	2.18	1.93	1.73	1.56	1.42	1.29	1.19	1.01
23	0.119	0.51	0.86	1.12	1.61	2.16	2.55	2.93	3.30	3.59	3.07	2.66	2.33	2.07	1.85	1.67	1.51	1 38	1.27	1.06
24	0.125	0.53	0.90	1.17	1.69	2.26	2.67	3.07	3.46	3.83	3.27	2.83	2.48	2.20	1.97	1.78	1.61	1.47	1.35	1.16
25	0.131	0.56	0.94	1.22	1.76	2.37	2.79	3.20	3.61	4.07	3.48	3.01	2.64	2.34	2.10	1.89	1 72	1.52	1.44	1.23
28	0.148	0.63	1.07	1.38	1.99	2.67	3.15	3.62	4.28	4.54	4.12	3.57	3.13	2.78	2.49	2.24	2.04	1.86	1.71	1.46
30	0.159	0.68	1.15	1.49	2.14	2.88	3.39	3.90	4.40	4.89	4.57	3.96	3.47	3.08	2.76	2.49	2.26	2.06	1.89	1.62
32	0.170	0.73	1.23	1.60	2.30	3.09	3.64	4.18	4.71	5.24	5.03	4.36	3.83	3.39	3.04	2 74	2.49	2 27	2.06	1.78
35	0.188	0.80	1.36	1.76	2.53	3.40	4.31	4.62	5.19	5.78	5.76	4.99	4.38	3.88	3.48	3 13	2.85	2.60	2.38	2.04
40	0.217	0.92	1.57	2.03	2.93	3.93	4.63	5.32	6.00	6.67	7.04	6.10	5.35	4.75	4.25	3.83	3.48	3.17	2.91	2.49
45	0.246	1.05	1.78	2.31	3.32	4.46	5.26	6.04	6.81	7.58	8.33	7.28	6.39	5.66	5.07	4 57	415	3 70	3.48	2.97
50	0.276	1.18	1.99	2.58	3.72	5.00	5.89	6.77	7.64	8.49	9.33	8.52	7.48	6.63	5.93	5 35	4.96	4 44	4.07	3.48
55	0.306	1.30	2.21	2.96	4.12	5.54	6.53	7.51	8.46	9.41	10.3	9.83	8.63	7.65	6.85	6.17	5.60	5.12	4.76	4.01
60	0.336	1.43	2.43	3.15	4.53	6.09	7.18	8.25	9.30	10.3	11.3	11.2	9.83	8.72	7.80	7.03	6.38	5.83	5.35	4.57
		Тур	e II		ш							Type	IV lubric	ation						

Type I – Manual lubrication; Type II – Drip lubrication; Type III = Oil bath lubrication; Type IV – Oil stream lubrication



Service factors for rolling chains.

	Type of input power								
Type of driven load	Internal combustion engine with hydraulic drive	Electric motor or turbine	Internal combustion engine with mechanical drive						
Smooth	1.0	1.0	1.2						
Moderate shock	1.2	1.3	1.4						
Heavy shock	1.4	1.5	1.7						

Multiple-strand factors for rolling chains.

Number of strands	Multiple-strand factor, a_2
2	1.7
3	2.5
4	3.3



Example 9 – Chain selection

A four strand no 25 rolling chain transmits power from a 21 tooth driving sprocket that rotates at 1200 rpm. The speed ratio is 4:1

Determine:

- a) Rated power of this drive
- b) Tension in the chain
- c) Safety factor of the chain based on the minimum tensile strength
- *d)* Chain length if the center distance is 254 mm

a) Pow=2.845kW
b) F=1242.2 N
c) fs=11.17
d) L/pt=135 L= 857.25 mm



Coursework Example 10 – Belt exercise

A pump is driven by an electric motor through a open type flat belt drive.

Motor pulley diameter(d_S) = 300 mm, Pump pulley diameter(d_L) = 600 mm

Coefficient of friction (μ_S) for motor pulley = 0.25

Coefficient of friction (μ_L) for pump pulley = 0.20

Center distance between the pulleys=1000 mm; Rotational speed of the motor=1440 rpm;

Power transmission = 20kW; density of belt material (ρ)= 1000 kg/m³; allowable stress for the belt material (σ) = 2 MPa; thickness of the belt = 5mm.

Determine the belt specifications.

Length L=3436mm; breadth b=240mm and thickness t=5mm