Belts and chains

Introduction:

Power transmission between shafts can be accomplished in a variety of ways such as:

1- Non flexible drives (Gears)
2- Flexible drives (Belts, Ropes and Chains)

The advantages of flexible drives over rigid drives are:

(i) Flexible drives transmit power over comparatively long distance due to an intermediate link between driving and driven shafts.

(ii) Since the intermediate link is long and flexible , it absorbs shock loads and damps vibrations.

(iii) Flexible drives provide considerable flexibility in the location of the driving and driven shafts.

(iv) Flexible drives are cheap compared to gear drives. There initial maintenance costs are low.

The disadvantages of flexible drives are :

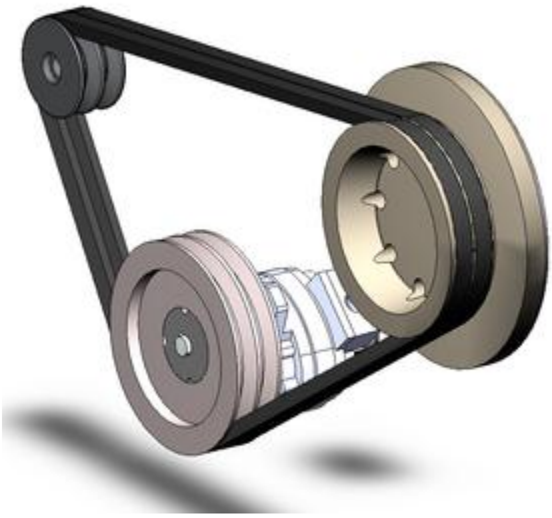
(i) They occupy more space.

(ii) The velocity ratio is relatively small.

(iii) The velocity ratio is not constant.

Belt drives offer the following advantages compared with other types.

(i) They can transmit power over considerable distance between and driven shafts as shown in figure(1).



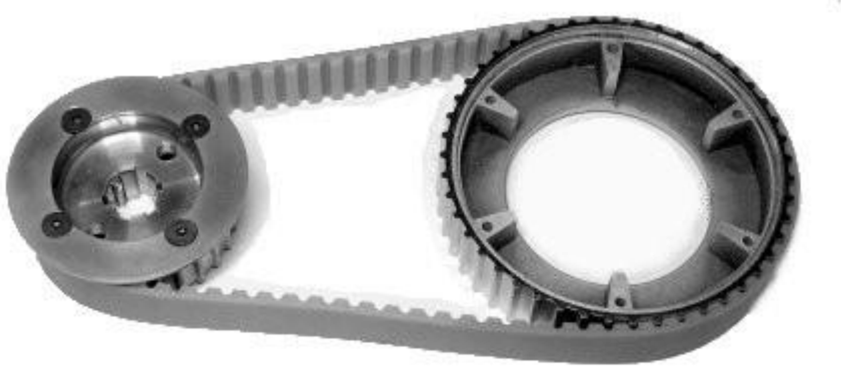


Fig.(1) Belt drive

(ii) The operation of belt drive is smooth and silent.

(iii) They can transmit only a definite load , which if exceeded, will cause the belt to slip over the pulley.

(iv) They have the ability to absorb the shocks and damp vibration.

(v) They are simple to design.

(vi) They have low initial cost.

Belt drives are mainly used in electric motors, automobiles, machine tools and conveyors.

Depending upon the shape of the cross-section, belts are classified as flat belts and V belts. Figure (2) shows a multiple V-belt.

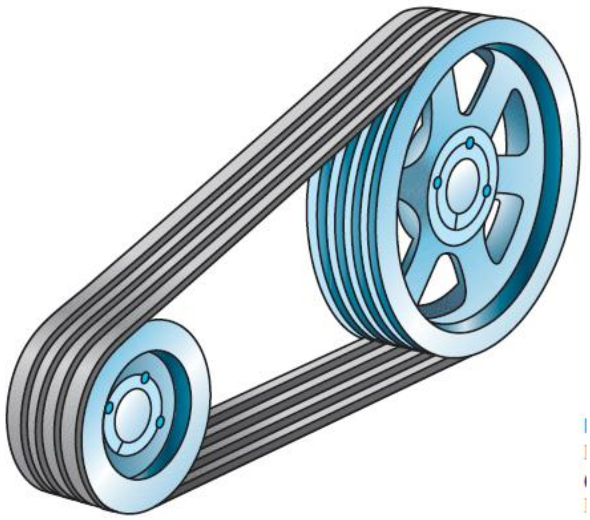


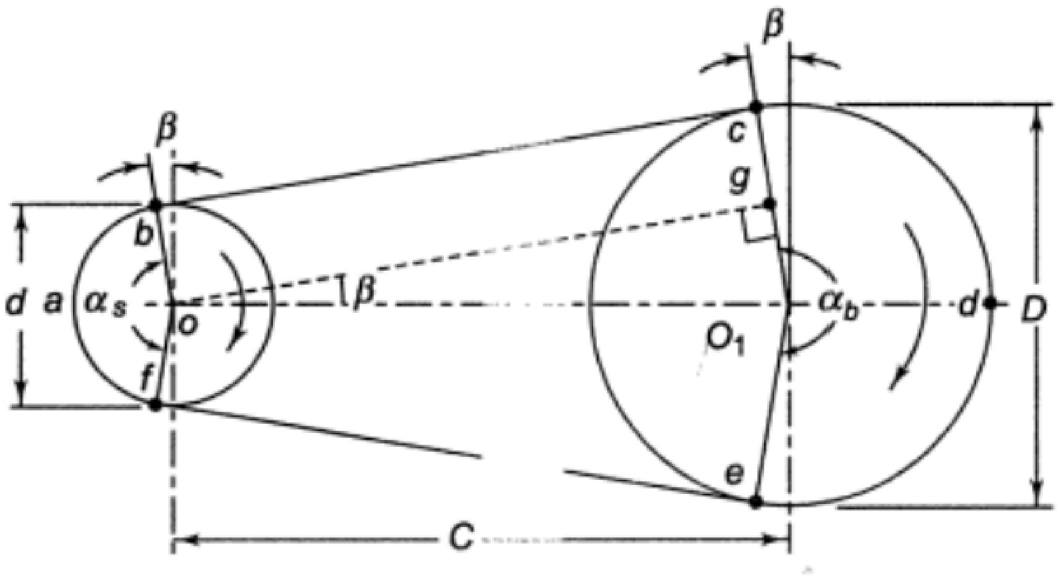
Fig.(2) Multiple V- Belt

Geometrical Relationships:

There are two types of belt construction

(i) Open belt drive (see figure 3-a)

(ii) Crossed belt drive (see figure 3-b)



(a) Open belt drive

$$sin\beta = \frac{(D-d)}{2C}$$

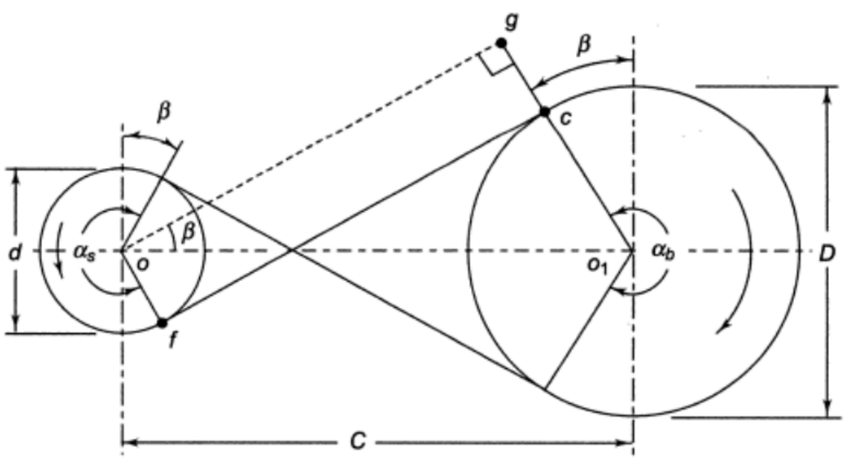
$$\alpha_s = 180 - 2sin^{-1}(\frac{D-d}{2C})$$

$$\alpha_b = 180 + 2sin^{-1}(\frac{D-d}{2C})$$

For open belt drive the length of the belt can be calculated as:

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

(1)



(b) Crossed Belt drive

$$sin\beta = \frac{(D+d)}{2C}$$

$$\alpha_s = \alpha_b = 180 + 2sin^{-1}(\frac{D+d}{2C})$$

Fig.(3) Belt construction

d= Diameter of small pulley(m)

D= Diameter of big pulley(m)

C= Center to center distance (m)

For the crossed belt drive the length of the belt can be calculated as

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C} \tag{2}$$

Analysis of belt tension:

The forces acting on the element of a flat belt are shown in figure (4).

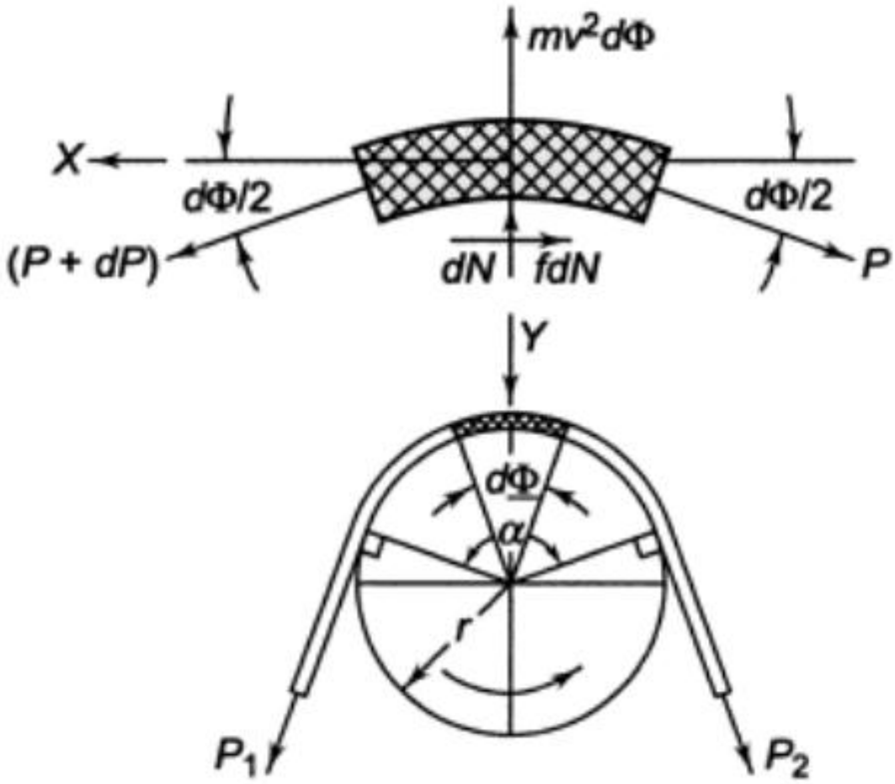
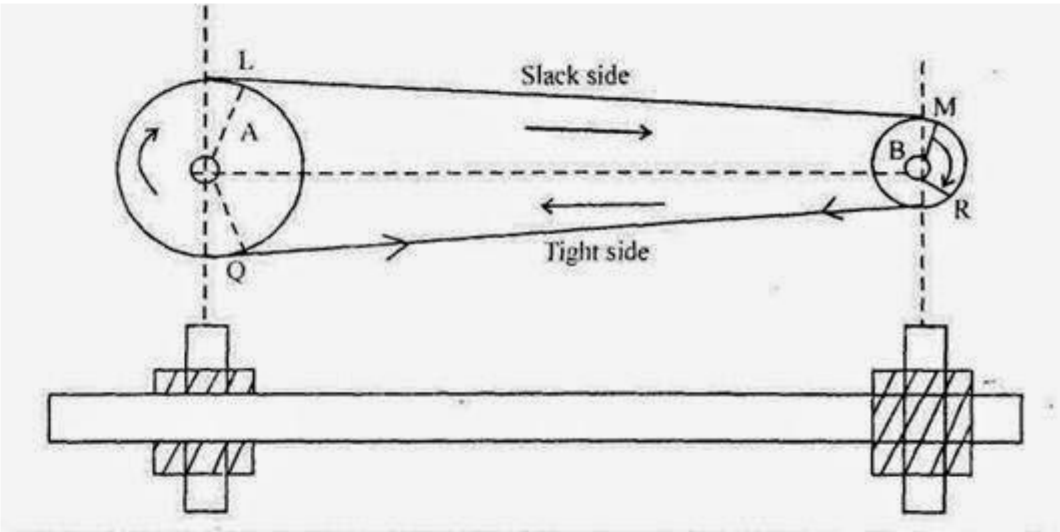


Fig.(4): Forces on flat belt

The relationship between the forces P_1 , P_2, and the centrifugal force for a flat belt can be expressed as:



$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

(3)

where

P_1= belt tension in the tight side(N)

P_2= belt tension in the loose side(N)

m=mass of the one meter length of the belt (kg/m)

v= belt velocity (m/s)

f= coefficient of friction

α=angle of warp for belt (radians)

The forces acting on the element of V-belt can be shown in figure (5)

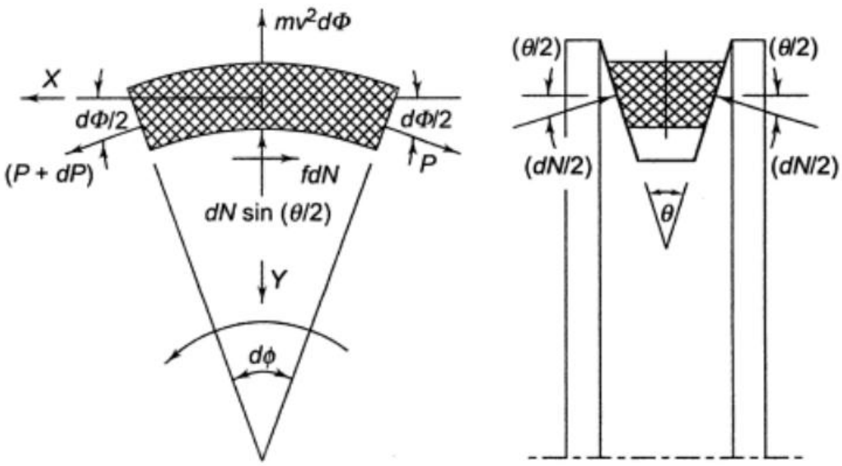


Fig.(5) Forces on V-Belt

The relationship between the forces P_1, P_2 and the centrifugal force can be expressed as

$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha/\sin(\frac{\theta}{2})} \tag{4}$$

Due to increased frictional force, the slip is less in V-belt compared with flat belt. The effective pull in the belt is $(P_1 - P_2)$ therefore the power transmitted by the belt can be calculated as:

Power transmitted=$(P_1 - P_2)v$ (5)

The units of power transmitted is (N.s/m or W)

<u>Condition for maximum power transmission:</u>

The belt is given an initial tension P_i in order to transmit power. The initial tension depends upon the length of the belt, the elasticity of the belt material, the geometry of pulleys and the center distance. When the driving pulley begins to rotate the elongation on the tight side is proportional to $(P_1 - P_i)$ while the elongation on loose side is proportional to $(P_i - P_2)$. For constant belt length the two elongations are equal.

$(P_1 - P_i) = (P_i - P_2)$

Hence

$$P_i = \frac{P_1 + P_2}{2} \tag{6}$$

Since

$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

This equation can be written as

$$\frac{P_2 - mv^2}{P_1 - mv^2} = e^{-f\alpha}$$

Or

$$\frac{(P_2 - mv^2) + (P_1 - mv^2)}{(P_2 - mv^2) - (P_1 - mv^2)} = \frac{e^{-f\alpha} + 1}{e^{-f\alpha} - 1} \qquad (7)$$

Substituting equation (6) into equation (7) to get

$$\frac{2P_i - 2mv^2}{-(P_1 - P_2)} = \frac{e^{-f\alpha} + 1}{e^{-f\alpha} - 1}$$

Or

$$(P_1 - P_2) = 2(P_i - mv^2) \times \frac{1 - e^{-f\alpha}}{e^{-f\alpha} + 1}$$

Therefore

Power= $(P_1 - P_2)v = 2(P_i v - mv^3) \times \frac{1-e^{-f\alpha}}{1+e^{-f\alpha}}$

Differentiating power with respect to (v) and equate the result to zero

$\frac{\partial}{\partial v}(Power) = 0$ or $\frac{\partial}{\partial v}(P_i v - mv^3) = 0$

$$P_i - 3mv^2 = 0$$

The optimum velocity of the belt for maximum power transmission is given by: $v = \sqrt{\frac{P_i}{3m}}$

Ex1:

The layout of a leather belt drive transmitting 15 kW of power is shown in figure(6). The center distance between the pulleys is twice the diameter of the bigger pulley. The belt should operate at a velocity of 20m/s approximately and the stresses in the belt should not exceed2.25N /mm^2. The density of leather is 0.95 g/cc and the coefficient of friction is 0.35. The thickness of the belt is 5mm. Calculate

(i) The diameter of pulleys

(ii) The length and the width of the belt

(iii) The belt tensions

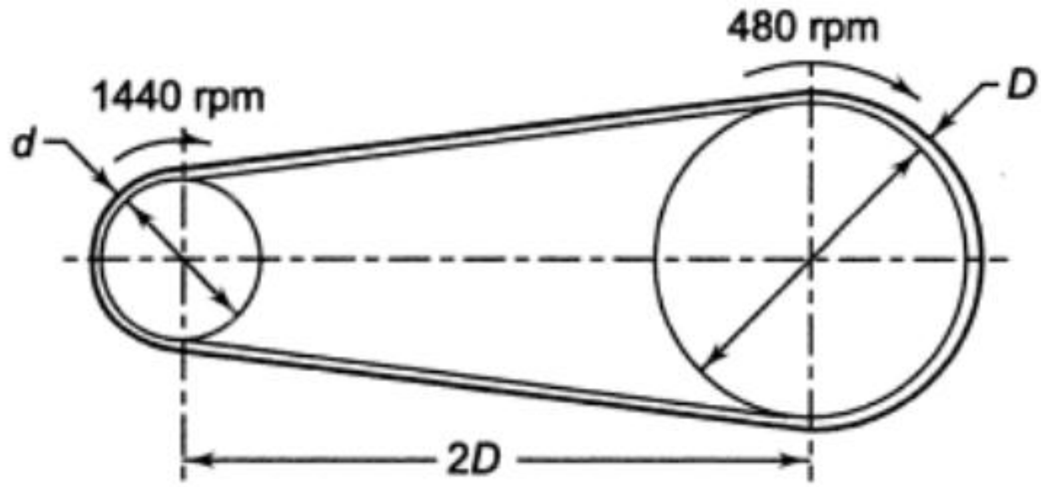


Fig.(6)

Solution To find the diameter of the pulley,

$$v = \omega \times r$$

$$v = 2 \times \pi \times N \times r/60$$

Or
$$v = \pi \times N \times d/60$$

$$d = \frac{60 \times v}{\pi \times N}$$

$$d = \frac{60 \times 20 \times 1000}{\pi \times 1440} = 265.25mm = 270mm$$

$$\frac{N_1}{N_2} = \frac{D}{d}$$

$$\frac{1440}{480} = \frac{D}{d} = \frac{D}{270}$$

$$\therefore D = 810mm$$

$$C = 2D = 2(810) = 1620mm$$

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

$$= 2(1620) + \frac{\pi(810 + 270)}{2} + \frac{(810 - 270)^2}{4(1620)} = 4981.46mm$$

To evaluate the belt width and belt tension, the corrected velocity can be evaluated as

$$v = \pi \times N \times d/60$$

$$v = \pi \times 1440 \times \frac{0.270}{60} = 20.35\ m/s$$

$$\alpha_s = 180 - 2sin^{-1}(\frac{D-d}{2C})$$

$$\alpha_s = 180 - 2sin^{-1}\left(\frac{810 - 270}{2 \times 1620}\right) = 160.8 = 2.81\ rad$$

The volume of 1 meter belt in cubic cm is given by:

$$volume = (length) \times (width) \times (tickness)$$

$$volume = (100)(\frac{b}{10})(\frac{5}{10})$$

Where b is the width in mm

The mass of 1m length of the belt can be calculated as:

$m = density\ \times volume = 0.95 \times 5 \times b = 4.75b\,\frac{g}{m} = 4.75b \times 10^{-3}kg/m$

$$mv^2 = 4.75b \times 10^{-3}(20.35)^2 = 1.97b$$

Also $e^{f\alpha} = e^{0.35 \times 2.81} = 2.67$

$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

$$\frac{P_1 - 1.97b}{P_2 - 1.97b} = 2.67$$

Or $P_1 - 2{,}67P_2 + 3.29b = 0$ (a)

The maximum stress in the belt is given as 2.25N/mm^2

$$\sigma = \frac{maximum\ tension}{cross - sectional\ area\ of\ the\ belt} = \frac{P_1}{A}$$

$\therefore P_1 = \sigma\, A = 2.25(5b) = (11.25b)N$ (b)

Also $P_1 - P_2 = \frac{Power}{v} = \frac{15\times1000}{20.36}$=736.73 N (c)

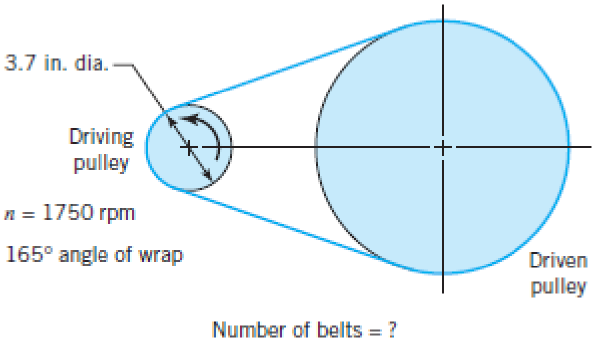
Solve equations a,b and c to get

$b = 127.02mm\ or\ 130mm$

$$P_1 = 1428.98N\ and\ P_2 = 692.26N$$

Ex 2:

A 25-hp, 1750-rpm electric motor drives a machine through a multiple V-belt. The size 5 V-belts used have an angle,θ, of 36° and a unit weight of 0.012 lb/in. The pulley on the motor shaft has a 3.7-in. pitch diameter (a standard size), and the geometry is such that the angle of wrap is 165°. It is conservatively assumed that the maximum belt tension should be limited to 150 lb, and that the coefficient of friction will be at least 0.20. How many belts are required?



Multiple V-belt θ=18^o ,

Unit weight=0.012 lb/in

Power input=25hp

P_{max}=P_1=150lb

f= 0.2

$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha/\sin(\frac{\theta}{2})}$$

$$v = 2\times\pi\times N\times\frac{r}{60} = 2\times\pi\times1750\times\frac{3.7}{60} = 339\frac{in}{s}$$

$$mv^2 = 0.012\times339^2 = 1379\frac{lb.in}{s^2}$$

Note

Since the lb_f =$32.2\frac{lb_m\,ft}{s^2}$

So that $mv^2 = \frac{1379}{32\times12} = 3.59lb$

$$\emptyset = 165 \times \frac{\pi}{180} = 2.88\, rad$$

$$e^{f\emptyset/\sin(\frac{\theta}{2})} = e^{0.2\times2.88/sin18} = 6.42$$

$$\frac{150-3.59}{P_2-3.59} = \ 6.42$$

$$\therefore P_2 = 26.3lb$$

The torque transmitted by one belt can be calculated as

$$T = (P_1 - P_2)r = (150-26.3)\frac{3.7}{2} = 229lb.in$$

Note 1hp=33000lb.ft/min

Hence the power transmitted by one belt can be calculated as

$$\boldsymbol{Power = T(lb.ft) \times N\left(\frac{rad}{min}\right) = \frac{229\times1750\times2\pi}{12}}$$

$$\boldsymbol{= 209725.88lb.ft/min}$$

Or $\boldsymbol{in\ hp\ unit = \frac{209725}{33000} = 6.35hp/belt}$

$$\therefore Number\ of\ belt\ required = \frac{total\ power}{power/belt} = \frac{25}{6.35} = 3.93belt$$

4 belts are required

<u>Ex(3) :</u>

The following data given for a V-belt drive connecting a 20kW motor to a compressor.

	Motor pulley	Compressor pulley
Pitch diameter	300	900
Rotational speed(rpm)	1440	480
Coefficient of friction	0.2	0.2

The center distance between pulleys is 1m and the dimensions of the belt cross section is given in figure(7). The density of the composite belt is

0.97 g/cc and allowable tension per belt is 850N. How many belts required for this application.

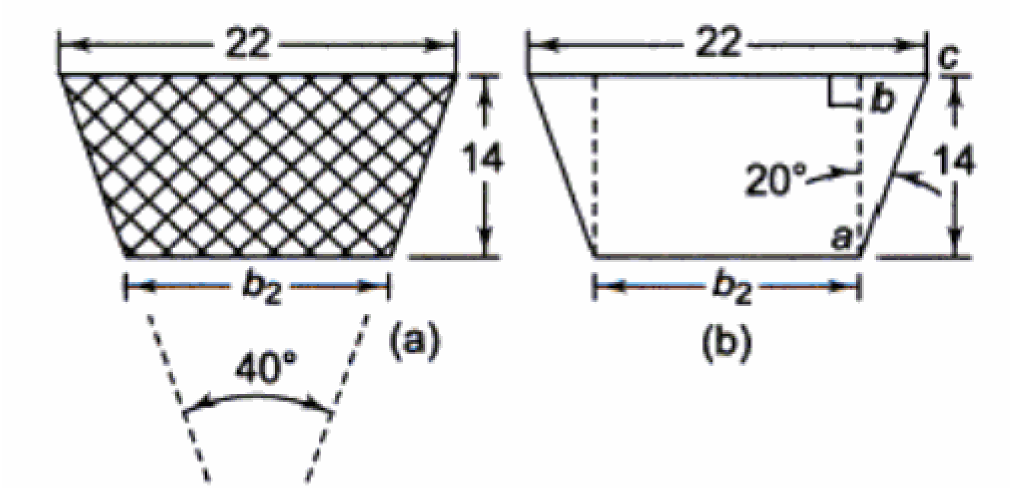


Fig.(7)

Solution:

$$\alpha_s = 180 - 2sin^{-1}(\frac{D-d}{2C})$$

$$\alpha_s = 180 - 2sin^{-1}\left(\frac{900-300}{2\times 1000}\right) = 145.07^o$$

Or $\alpha_s = \left(\frac{145.07\times\pi}{180}\right) = 2.53$ rad

$$e^{f\alpha/\sin(\frac{\theta}{2})} = e^{0.2\times 2.53/\sin 20} = 4.4$$

$$bc = 14\times tan20 = 5.09mm$$

$$b_2 = 22 - 2\times 5.09 = 11.81mm$$

$$\therefore Area\ of\ cross-section = \frac{1}{2}\times(11.81+22)\times 14$$

$$= 236.67mm^2 = 236.67\times 10^{-2}cm^2$$

The length of one meter is 100cm. Therefore the mass of the belt(m) per meter length is given by

Mass= density× volume of the belt

$$= (0.97) \times (236.67 \times 10^{-2})(100) = \frac{230gm}{m} = 0.23kg/m$$

To calculate the power transmitted by one belt

$$v = \frac{\pi dn}{60 \times 1000} = \frac{\pi \times 300 \times 1440}{60 \times 1000} = 22.62m/s$$

$$mv^2 = 0.23 \times (22.62)^2 = 117.68$$

$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha/\sin(\frac{\theta}{2})}$$

$$\frac{P_1 - 117.68}{P_2 - 117.68} = 4.4$$

The allowable tension in the belt is given as 850N i.e $P_1 = 850\ N$

$$\therefore (P_2 - 117.8) \times 4.4 = 850 - 117.68$$

$$P_2 = 284.2N$$

$$\frac{Power}{belt} = (P_1 - P_2) \times v = (850 - 284) \times 22.6 = 12791.6W$$

$$= 12.791kW$$

$$Number\ of\ belts\ required = \frac{Total\ power\ transmitted}{\frac{power}{belt}}$$

$$Number\ of\ belts\ required = \frac{20}{12.791} = 1.56$$

Use 2 belts

Ex(4):

The following data is given for an open type V-belt drive:

Diameter of driving pulley=150mm

Diameter of driven pulley=300mm

Center distance=1m

Groove angle=40^o

Mass of belt=0.25kg/m

Maximum permissible tension=750N

Coefficient of friction=0.2

Calculate the maximum power transmitted by the belt and the corresponding belt velocity. Neglect power losses.

$$\alpha_s = 180 - 2sin^{-1}(\frac{D-d}{2C})$$

$$\alpha_s = 180 - 2sin^{-1}\left(\frac{300-150}{2\times 1000}\right) = 171.4^o or\ 2.99rad$$

$$e^{f\alpha/\sin(\frac{\theta}{2})} = \ e^{0.2\times 2.99/\sin 20} = 5.75$$

$$\frac{P_1 - mv^2}{P_2 - mv^2} = \ e^{f\alpha/\sin(\frac{\theta}{2})}$$

$$\frac{P_1 - 0.25v^2}{P_2 - 0.25v^2} = 5.75$$

The belt tension is maximum when v=0.Hence

$$\frac{P_1}{P_2} = 5.75$$

Since $P_1 = 750N$

$$\therefore P_2 = \frac{P_1}{5.75} = \frac{750}{5.75} = 130.43N$$

$$P_i = \frac{(P_1 - P_2)}{2} = \frac{(750 + 130.43)}{2} = 440.22N$$

For maximum power transmission

$$v = \sqrt{\frac{P_i}{3m}} = \sqrt{\frac{440.22}{3\times 0.25}} = 24.23m/s$$

Maximum power transmission

$$P_1 + P_2 = 2P_i$$

$$P_1 + P_2 - 2(440.22) = 0$$

Or

$$P_1 + P_2 - 880.44 = 0$$

Since v=24.23m/s

$$\frac{P_1 - 0.25(24.23)^2}{P_2 - 0.25(24.23)^2} = 5.75$$

Solving the above equations give

$$P_1 = 646.73N \; and \; P_2 = 233.7N$$

$$kW = \frac{(P_1 - P_2)v}{1000} = \frac{(646.73 - 233.7)(24.23)}{1000} = 10$$

Belt tensioning method:

A loose belt mounted on the pulleys does not transmit any load. Therefore belts are provided with initial tension in order to transmit power. When a new belt is mounted on pulleys under tension, it loses its initial tension due to elongation during its service life. Therefore, a provision should be made to adjust the belt tension from time to time. There are number of methods to adjust the belt tension as shown in figure (8) .

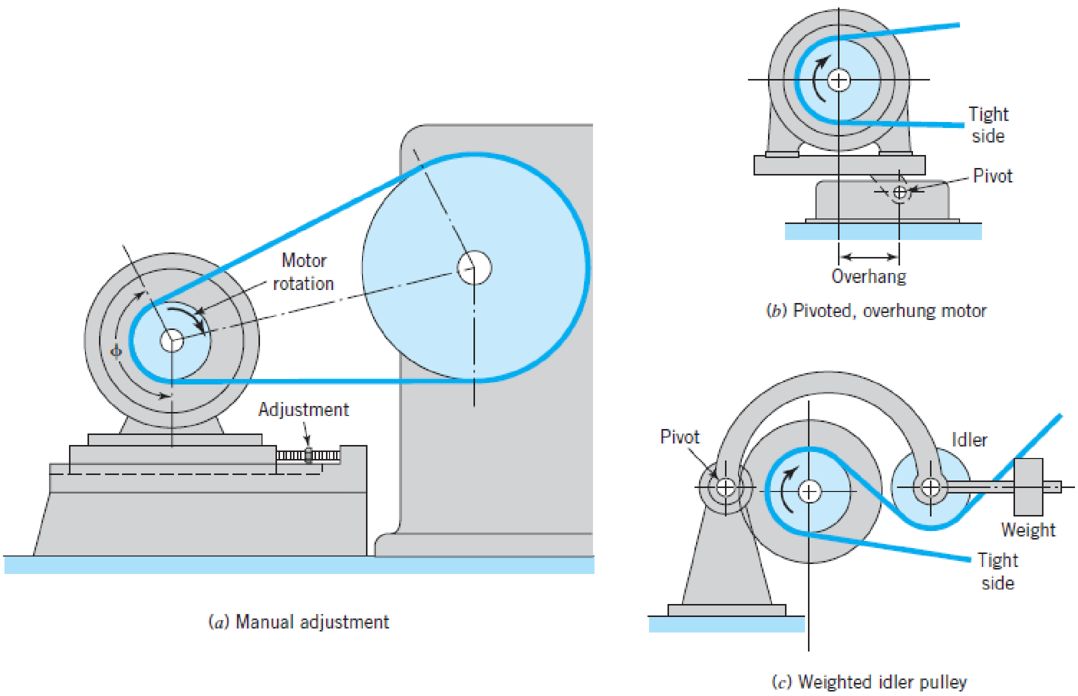


Fig.(8) Belt tensioning methods

Note that the capacity of the belt drive is determined by the angle of wrap $\emptyset$ on the smaller pulley and that this is particularly critical for drives in which pulleys of greatly differing size are spaced closely together. Initial tensioning of the belt overload the bearing and shaft as well as well as shorten belt life.

Selection of V-belts from manufaturerer catalogue:

EX(5) It is required to select a V-belt drive to connect a 15kW, 2880 rpm normal torque A.C. motor to a centrifugal pump, running at approximately 2400 rpm, for a service of 18 hour per day. The center distance should be approximately 400mm. Assume that the pitch diameter of the driving pulley is 125mm.

Step1: Select correction factor according to service (F_a) from table (1) (for normal torque A.C. motor and 18 hr per day)

$$F_a=1.2$$

Step 2: Calculate the design power

$$\boldsymbol{Design\ Power = F_a(transmitted\ power)}$$

$$\boldsymbol{= 1.2(15) = 18kW}$$

Step 3 Type of cross-section for belt

Plot a point with co-ordinates of 18kW and 2880rpm speed in fig.(9). It is observed that point is located in the region of B-section belt. Therefore for this application the cross-section of the V-belt is B.

Step4 calculate the diameter of smaller and bigger pulleys. Since the pitch diameter of the smaller pulley is given as 125mm

$$Speed\ ratio = \frac{2880}{2400} = 1.2$$

$$d = 125mm, D = 1.2 \times 125 = 150mm$$

It is observed from table (2) that both diameter have preferred values

Step5 calculate the length of the belt

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

$$L = 2(400) + \frac{(150-125)^2}{4(400)} + \frac{\pi(150+125)}{2} = 1232.36mm$$

Step6 From table (3) the preferred pitch length for B- section belt is 1210mm or 1370mm. It is assumed that the length is 1210mm.

Step 7 correct the center distance. Substituting the value of the belt length to get the corrected center distance.

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

$$1210 = 2C + \frac{(150-125)^2}{4C} + \frac{\pi(150+125)}{2}$$

Simplifying the above expression to get

$$C^2 - 389C + 78.12 = 0$$

$$C = \frac{389 \mp \sqrt{389^2 - 4(78.12)}}{2} = 388.8mm$$

The corrected center distance is 388.8mm

Step8 Correction factor for belt pitch length(F_c) . From table (4)(B-section and 1210 mm pitch length)

$$F_c = 0.87$$

Step 9 Correction factor for contact

$$\boldsymbol{\alpha_s = 180 - 2sin^{-1}\left(\frac{D-d}{2C}\right) = 180 - 2sin^{-1}\left(\frac{150-125}{2\times 388.8}\right) = 176^o or\ 177^o}$$

From table (5) F_d=0.99

Step (10) Calculate the power rating of single V-belt

From table (6) (2800rpm, 125mm pulley, B section ,speed ratio=1.2)

$$P_r = 3.96 + 0.5 = 4.46kW$$

Step (11) Calculate the number of belts as

$$Number\ of\ belts = \frac{P \times F_a}{P_r \times F_c \times F_d} = \frac{15(1.2)}{4.46(0.87)(0.99)} = 4.69\ or\ 5\ belts$$

Table(1) correction factor according to service(F_a)

Service	Type of driven Machine	Type of driving units					
		AC Motor: normal torque, squirrel cage, synchronous and split phase *DC Motor*: shunt wound—multi cylinder IC engine over 600 rpm			*AC Motor*: high torque, induction, single phase *DC Motor*: series and compound wound—*single cylinder IC engine*, Multi cylinder IC engine under 600 rpm—line shaft, *clutches and brakes*		
		Operational hours per day (h)			Operational hours per day (h)		
		0–10	10–16	16–24	0–10	10–16	16–24
Light duty	Agitator, blower, exhauster, centrifugal pumps, compressor and fans up to 7.5 kW and light duty conveyor	1.0	1.1	1.2	1.1	1.2	1.3
Medium duty	Belt conveyor, fans over 7.5 kW, generator, line shaft, machine tools, presses, positive displacement pumps and vibrating screen	1.1	1.2	1.3	1.2	1.3	1.4
Heavy duty	Bucket elevator, hammer mill, piston pump, saw mill, exciter and wood working machinery	1.2	1.3	1.4	1.4	1.5	1.6
Extra-heavy duty	Crusher, mill and hoist	1.3	1.4	1.5	1.5	1.6	1.8

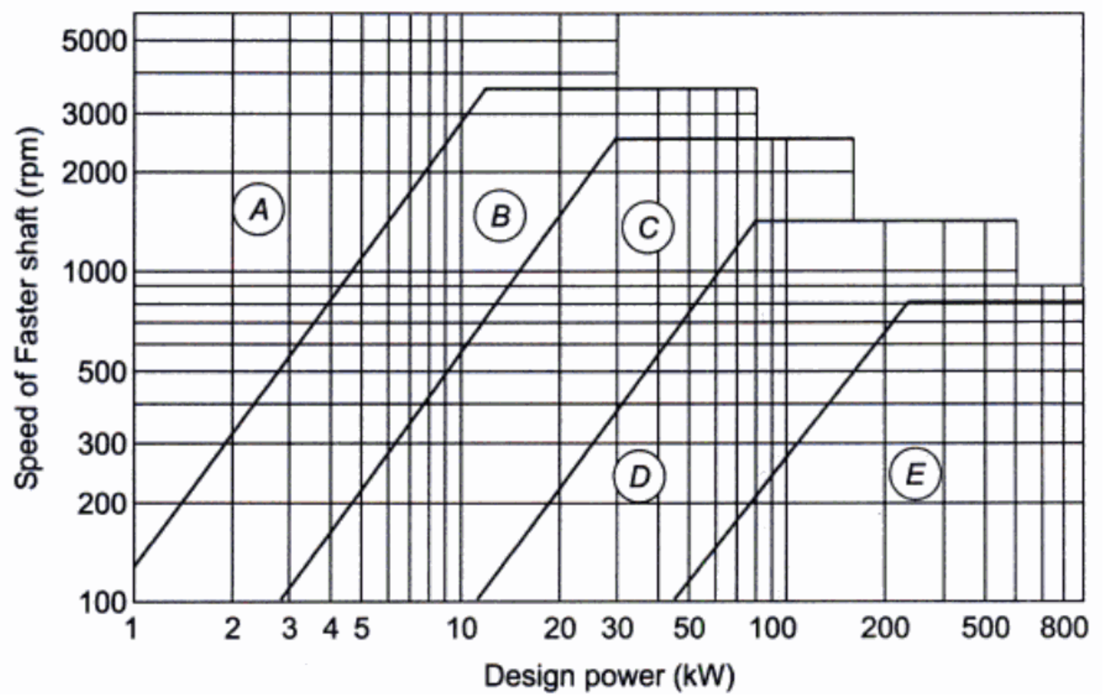


Fig.(9)

Table(2)

Belt section					
Z	*A*	*B*	*C*	*D*	*E*
50	75	125	200	355	500
53	80	132	212	375	530
56	85	140	224	400	560
60	90	150	236	425	600
63	95	160	250	450	630
67	100	170	265	475	670
71	106	180	280	500	710
75	112	190	300	530	750
80	118	200	315	560	800
85	125	224	355	600	900
90	132	250	375	630	1000
95	140	280	400	710	1120
100	150	300	450	750	1250
112	160	315	500	800	1400
125	170	355	530	900	1500
140	180	375	560	1000	1600
160	190	400	600	1060	1800
180	200	450	630	1120	1900
200	224	500	710	1250	2000
250	250	530	750	1400	2240
315	280	560	800	1500	2500
400	300	600	900	1600	—
500	315	630	1000	1800	—
630	350	710	1200	2000	—
800	400	750	1250	—	—
—	450	800	1400	—	—
—	500	900	1600	—	—
—	560	1000	—	—	—
—	630	1120	—	—	—
—	710	—	—	—	—
—	800	—	—	—	—

Table(3)

Pitch lengths of belts L_p (mm)					
Z	*A*	*B*	*C*	*D*	*E*
405	630	930	1560	2740	4660
475	700	1000	1760	3130	5040
530	790	1100	1950	3330	5420
625	890	1210	2190	3730	6100
700	990	1370	2420	4080	6850
780	1100	1560	2720	4620	7650
920	1250	1690	2880	5400	9150
1080	1430	1760	3080	6100	12230
1330	1550	1950	3310	6840	13750
1420	1640	2180	3520	7620	15280
1540	1750	2300	4060	8410	16800
	1940	2500	4600	9140	
	2050	2700	5380	10700	
	2200	2870	6100	12200	
	2300	3200	6820	13700	
	2480	3600	7600	15200	
	2570	4060	9100		
	2700	4430	10700		
	2910	4820			
	3080	5370			
	3290	6070			
	3540				

Table(4)

Correction Factor	*Belt pitch length (mm)*					
	Belt cross section					
	Z	*A*	*B*	*C*	*D*	*E*
0.80		630				
0.81			930			
0.82		700		1560	2740	
0.83			1000			
0.84		790		1760		
0.85			1100			
0.86	405	890			3130	
0.87			1210	1950	3330	
0.88		990				
0.89						
0.90	475	1100	1370	2190	3730	4660
0.91				2340		
0.92	530		1560	2490	4080	5040
0.93		1250				
0.94				2720	4620	5420
0.95	625		1760	2800		
0.96		1430		3080		6100
0.97			1950		5400	
0.98	700	1550		3310		
0.99		1640	2180	3520		6850
1.00	780	1750	2300		6100	
1.02		1940	2500	4060		7650
1.03					6840	
1.04	920	2050	2700			
1.05		2200	2850	4600	7620	9150
1.06		2300				
1.07	1080				8410	9950
1.08		2480	3200	5380		
1.09		2570			9140	10710
1.10		2700	3600			
1.11				6100		
1.12		2910			10700	12230
1.13		3080	4060			
1.14		3290		6860		13750
1.15			4430			
1.16		3540	4820	7600	12200	
1.17			5000		13700	15280
1.18			5370			
1.19			6070		15200	16800
1.20				9100		
1.21				10700		

Table (5)

$\dfrac{D-d}{C}$	Arc of contact on smaller pulley (in degrees)	Correction Factor F_d
0.00	180	1.00
0.05	177	0.99
0.10	174	0.99
0.15	171	0.98
0.20	169	0.97
0.25	166	0.97
0.30	163	0.96
0.35	160	0.95
0.40	157	0.94
0.45	154	0.93
0.50	151	0.93
0.55	148	0.92
0.60	145	0.91
0.65	142	0.90
0.70	139	0.89
0.75	136	0.88
0.80	133	0.87
0.85	130	0.86
0.90	127	0.85
0.95	123	0.83
1.00	120	0.82

Table(6)

Speed of faster shaft	Power rating for smaller pulley pitch diameter of									Additional power increment per belt for speed ratio of									
	125 mm	132 mm	140 mm	150 mm	160 mm	170 mm	180 mm	190 mm	200 mm	1.00 to 1.01	1.02 to 1.04	1.05 to 1.08	1.09 to 1.12	1.13 to 1.18	1.19 to 1.24	1.25 to 1.34	1.35 to 1.51	1.52 to 1.99	2.00 and over
rpm	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW
720	1.61	1.79	1.99	2.24	2.48	2.73	2.97	3.21	3.45	0.00	0.03	0.05	0.08	0.10	0.13	0.15	0.18	0.20	0.23
960	2.02	2.24	2.50	2.82	3.13	3.44	3.75	4.05	4.35	0.00	0.03	0.07	0.10	0.14	0.17	0.20	0.24	0.27	0.30
1440	2.72	3.03	3.39	3.83	4.26	4.68	5.09	5.50	5.90	0.00	0.05	0.10	0.15	0.20	0.25	0.30	0.36	0.41	0.46
2880	3.96	4.44	4.95	5.55	6.11	6.62	7.08	7.48	–	0.00	0.10	0.20	0.30	0.41	0.50	0.61	0.71	0.81	0.91
100	0.32	0.35	0.38	0.43	0.47	0.51	0.55	0.59	0.63	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03
200	0.57	0.63	0.69	0.77	0.85	0.92	1.00	1.08	1.15	0.00	0.01	0.01	0.02	0.03	0.04	0.04	0.05	0.06	0.06
300	0.80	0.88	0.97	1.08	1.19	1.31	1.42	1.53	1.64	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
400	1.01	1.11	1.23	1.38	1.52	1.67	1.81	1.96	2.10	0.00	0.01	0.03	0.04	0.06	0.07	0.08	0.10	0.11	0.13
500	1.21	1.33	1.48	1.66	1.84	2.01	2.19	2.36	2.54	0.00	0.02	0.04	0.05	0.07	0.09	0.11	0.12	0.14	0.16
600	1.40	1.55	1.72	1.93	2.14	2.35	2.55	2.76	2.96	0.00	0.02	0.04	0.06	0.08	0.11	0.13	0.15	0.17	0.19
700	1.58	1.75	1.94	2.19	2.43	2.66	2.90	3.13	3.37	0.00	0.02	0.05	0.07	0.10	0.12	0.15	0.17	0.20	0.22
800	1.75	1.94	2.16	2.44	2.70	2.97	3.24	3.50	3.78	0.00	0.03	0.06	0.08	0.11	0.14	0.17	0.20	0.23	0.25
900	1.92	2.13	2.37	2.68	2.97	3.27	3.56	3.85	4.13	0.00	0.03	0.06	0.10	0.13	0.16	0.19	0.22	0.25	0.29
1000	2.08	2.31	2.58	2.91	3.23	3.55	3.87	4.18	4.49	0.00	0.04	0.07	0.10	0.14	0.18	0.21	0.25	0.28	0.32
1100	2.23	2.49	2.78	3.13	3.48	3.83	4.17	4.51	4.84	0.00	0.04	0.08	0.12	0.16	0.19	0.23	0.27	0.31	0.35
1200	2.38	2.66	2.96	3.35	3.72	4.09	4.46	4.81	5.17	0.00	0.04	0.08	0.13	0.17	0.21	0.25	0.30	0.34	0.38
1300	2.53	2.82	3.15	3.55	3.95	4.34	4.73	5.11	5.48	0.00	0.05	0.09	0.14	0.18	0.23	0.27	0.32	0.37	0.41
1400	2.66	2.97	3.32	3.75	4.17	4.59	4.98	5.39	5.78	0.00	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.39	0.44
1500	2.79	3.12	3.49	3.94	4.38	4.82	5.24	5.66	6.06	0.00	0.05	0.10	0.16	0.21	0.26	0.32	0.37	0.42	0.48
1600	2.92	3.26	3.65	4.12	4.58	5.04	5.48	5.91	6.33	0.00	0.06	0.11	0.17	0.23	0.28	0.34	0.39	0.45	0.51
1700	3.04	3.40	3.80	4.29	4.77	5.24	5.70	6.14	6.58	0.00	0.06	0.12	0.18	0.24	0.30	0.36	0.42	0.48	0.54
1800	3.15	3.52	3.94	4.45	4.95	5.44	5.90	6.36	6.80	0.00	0.06	0.13	0.19	0.25	0.32	0.38	0.44	0.51	0.57
1900	3.26	3.65	4.08	4.61	5.12	5.62	6.10	6.56	7.00	0.00	0.07	0.13	0.20	0.27	0.33	0.40	0.47	0.54	0.60
2000	3.36	3.76	4.21	4.75	5.28	5.78	6.27	6.74	7.19	0.00	0.07	0.14	0.21	0.28	0.35	0.42	0.49	0.56	0.63
2100	3.45	3.87	4.33	4.88	5.42	5.94	6.43	6.91	7.36	0.00	0.07	0.15	0.22	0.30	0.37	0.44	0.52	0.59	0.67
2200	3.54	4.00	4.44	5.01	5.55	6.07	6.58	7.05	7.50	0.00	0.08	0.16	0.23	0.31	0.39	0.46	0.54	0.62	0.70
2300	3.62	4.06	4.54	5.12	5.68	6.20	6.70	7.18	7.62	0.00	0.08	0.16	0.24	0.32	0.41	0.49	0.57	0.65	0.73