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Research for Compiling A Databook for The Designing of Belt Driven Power Transmission System

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ABSTRACT

This paper studies various parameters of designing the belt drives for power transmission. A new method is introduced here in this research work which utilizes analytically calculated data to design the power transmission module for belt drives. It has been found that a cumbersome calculation including twelve design parameters are ought to make while designing a belt drive. Therefore here in this paper an attempt has been made to use a databook to design a belt drive in an easy manner. Compared to conventional method, proposed method gives improved results in much less time. This databook will consist all the necessary parameters and the designing of belt driven power transmission system would become easy, efficient, time effective and calculation less.

Keywords: Transmission system, Belt drive, Rope drive, Chain drive.

I. INTRODUCTION

Belt drives are called flexible machine elements. Flexible machine elements are used for a large number of industrial applications, some of them are as follows:-

1. Used in conveying systems Transportation of coal, mineral ores etc. over a long distance.
2. Used for transmission of power. Mainly used for running of various industrial appliances using prime movers like electric motors, I.C. Engine etc.
3. Replacement of rigid type power transmission system.

A gear drive may be replaced by a belt transmission system. Flexible machine elements has got an inherent advantage that, it can absorb a good amount of shock and vibration. It can take care of some degree of misalignment between the driven and the driver machines and long distance power transmission, in comparison to other transmission systems, is possible. For the entire above reasons flexible machine elements are widely used in industrial application.

Although we have some other flexible drives like rope drive, roller chain drives etc. we will only discuss about belt drives.

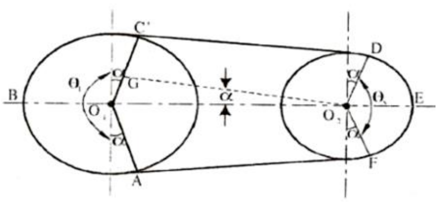

Figure 1. Belt Drive

II. METHODS AND MATERIAL

Literature Review:

Nomenclature of Open Belt Drive:

d_L - Diameter of the larger pulley.
d_S - Diameter of the smaller pulley.
α_L - Angle of wrap of the larger pulley.
α_S - Angle of wrap of the smaller pulley.
C - Center distance between the two pulleys.

Various Parameters

Associated With Belt Drives:

- Pich circle diameter.
- Initial tension.

- Maximum tension.
- Minimum tension.
- Cyclic variation.
- Belt speed.
- Belt length.
- Wrap angle.
- Torque of shaft.
- Drive ratio.

Belt Tensions:

The belt drives primarily operate on the friction principle, i.e., the friction between the belt and the pulley is responsible for transmitting power from one pulley to the other. In other words the driving pulley will give a motion to the belt and the motion of the belt will be transmitted to the driven pulley. Due to the presence of friction between the pulley and the belt surfaces, tensions on both the sides of the belt are not equal. So it is important that one has to identify the higher tension side and the lower tension side, which is shown in Fig. 2.

When the driving pulley rotates (in this case, anti-clock wise), from the fundamental concept of friction, we know that the belt will oppose the motion of the pulley. Thereby, the friction, 'f' on the belt will be opposite to the motion of the pulley. Friction in the belt acts in the direction, as shown in Fig.2, and will impart a motion on the belt in the same direction. The friction 'f' acts in the same direction as T_2. Equilibrium of the belt segment suggests that T_1 is higher than T2. Here, we will refer T_1 as the tight side and T_2 as the slack side, ie, T_1 is higher tension side and T_2 is lower tension side.

Continuing the discussion on belt tension, the figures though they are continuous, are represented as two figures for the purpose of explanation. The driven pulley in the initial stages is not rotating. The basic nature of friction again suggests that the driven pulley opposes the motion of the belt. The directions of friction on the belt and the driven pulley are shown the figure. The frictional force on the driven pulley will create a motion in the direction shown in the figure. Equilibrium of the belt segment for driven pulley again suggests that T1 is higher than T2.

It is observed that the slack side of the belt is in the upper side and the tight side of the belt is in the lower side. The slack side of the belt, due to self-weight, will not be in a straight line but will sag and the angle of contact will increase. However, the tight side will not sag to that extent. Hence, the net effect will be an increase of the angle of contact or angle of wrap. It will be shown later that due to the increase in angle of contact, the power transmission capacity of the drive system will increase. On the other hand, if it is other way round, that is, if the slack side is on the lower side and the tight side is on the upper side, for the same reason as above, the angle of wrap will decrease and the power transmission capacity will also decrease. Hence, in case of horizontal drive system the tight side is on the lower side and the slack side is always on the upperside.

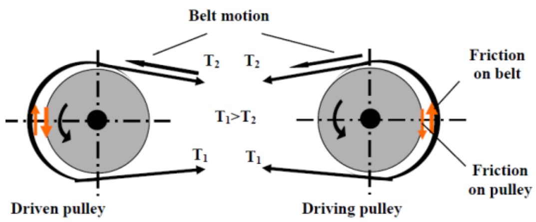

Figure 2. Belt Tension

Velocity Ratio of Belt Drive:

Velocity ratio of belt drive is defined as,

$$\frac{N_L}{N_S} = \frac{d_S + t}{d_L + t}(1 - s)$$

where,

NL and NS are the rotational speeds of the large and the small pulley respectively, 's' is the belt slip and 't' is the belt thickness.

'or' It is defined as, The ratio of angular velocity of the driver pulley to the angular velocity of the driven pulley is known as velocity ratio or speed ratio or transmission ratio.

Let,

d1 = Speed of driver pulley
d2 = Speed of driver pulley
n1 = Speed of driver pulley
n2 = Speed of driver pulley

Neglecting slip and thickness of belt,
Linear speed of belt on driver = Linear speed of belt on driven i.e., $\pi d1n1 = \pi d2n2$

Power Transmission of Belt Drive:

Power transmission of a belt drive is expressed as,

P = (T1 – T2)v

where,

$$\therefore \frac{n_1}{n_2} = \frac{d_2}{d_1}$$

$$\frac{\text{Speed of driver}}{\text{Speed of driven}} = \frac{\text{Diameter of the driven pulley}}{\text{Diameter of the driver pulley}}$$

Power Transmission of Belt Drive:

Power transmission of a belt drive is expressed as,

P = (T1 – T2)v

where,
'P' is the power transmission in Watt, and 'v' is the belt velocity in m/s.

Design Procedure for Belt Drives:

Designing of belt drives consist of calculating the following parameters;

- Unknown diameter or speed*.
- Velocity*.
- Constant 'k'*.
- Length of belt*.
- Initial tension in the belt*.
- Power*.
- Bearing force.
- Maximum tension/Minimum tension.
- Cyclic variation.
- Wrap angles.
- RPMs
- Torque.
- Drive ratio.

Note: (*) Necessary parameters for designing a belt drive.

Research Methodology:

It has been observed that the calculation for designing the belt drives for power transmission in machine elements are cumbersome and tidy, thus an attempt has been made here in this research work to compile a databook by which the designer can design a belt drive in less than five minutes. An online calculation mechanism (Ref. no.-13) has taken as a base for the compilation of the database. In this paper only eight table, using only one speed (RPM) value, two power (HP) values, four center distance (inches) values and five different pitch circle diameter (cms) values are used. While a complete databook will consist any value of speed, at every possible power value, for a centre distance which can vary from 0.1 meter to more than 8 meters, and 35 different standard pitch diameters of pulley. Compiling all of them in a databook will take hundreds of tables and thousands of graphs and relative indexes can be drawn.
In this research work, the RPM value is taken as **1400 RPM,** used powers are **0.5 HP** and **1 HP,** and centre distances are taken as **24, 36, 50** and **60 inches,** while pitch circle diameters are taken as **5, 10, 20, 50** and **60 centimeters.** This paper contains **3000 calculations,** any analytical value of the desired design parameter that comes as under above specification can be found with ease.

Tables prepared in this paper are;

1. When RPM of Driving pulley is **1400**, Power is **0.5 hp** and Center Distance is **24 inches.**
2. When RPM of Driving pulley is **1400**, Power is **0.5 hp** and Center Distance is **36 inches.**
3. When RPM of Driving pulley is **1400**, Power is **0.5 hp** and Center Distance is **50 inches.**
4. When RPM of Driving pulley is **1400**, Power is **0.5 hp** and Center Distance is **60 inches.**
5. When RPM of Driving pulley is **1400**, Power is **1 hp** and Center Distance is **24 inches.**
6. When RPM of Driving pulley is **1400**, Power is **1 hp** and Center Distance is **36 inches.**
7. When RPM of Driving pulley is **1400**, Power is **1 hp** and Center Distance is **50 inches.**
8. When RPM of Driving pulley is **1400**, Power is **1 hp** and Center Distance is **60 inches.**

Table 1 - When RPM of Driving pulley is 1400, Power is 0.5 hp and Center Distance is 24 inches

Pitch Diameter (Driving Shaft) (in Cms)	Pitch Diameter (Driven Shaft) (in Cms)	Initial Tension (in kg)	Bearing Force (in kg)	Maximum Tension (in kg)	Minimum Tension (in kg)	Cyclic Variation (in kg)	Belt Speed (in m/s)	Belt Length (in m)	Wrap Angle (Driving pulley) (in degrees)	Wrap Angle (Driven pulley) (in degrees)	RPM (Driven pulley)	Torque (Driving Shaft) (in N-m)	Torque (Driving Shaft) (in N-m)	Drive Ratio
5	5	10.92113	26.21081	13.10518	2.729263	10.37592	3.664204	1.376223	180	180	1400	2.542159	2.542159	1
	10	11.03861	26.49249	13.24625	2.87033	10.37592	3.664204	1.455801	175.288	184.704	700	2.542159	5.087029	0.5
	20	11.29489	27.11573	13.55786	3.181948	10.37592	3.664204	1.621104	165.864	194.135	350	2.542159	10.18084	0.25
	50	12.37172	29.69259	14.84607	4.470149	10.37592	3.664204	2.167128	136.679	223.32	140	2.542159	25.4365	0.1
	60	12.88768	30.93044	15.46522	5.088849	10.37592	3.664204	2.366493	126.36	233.631	117	2.542159	30.52489	0.08
10	5	5.904407	14.17112	7.085561	1.898736	5.186371	7.330354	1.455801	184.701	175.298	2800	2.543108	1.270401	2
	10	5.845894	14.03069	7.015254	1.828429	5.186371	7.330354	1.533347	180	180	1400	2.542159	2.542159	1
	20	5.967003	14.32171	7.160857	1.974032	5.186371	7.330354	1.694536	170.59	189.4	700	2.542159	5.084318	0.5
	50	6.460964	15.5065	7.753248	2.521064	5.186371	7.330354	2.227885	141.69	218.3	280	2.542159	12.71486	0.2
	60	6.693204	16.06351	8.031754	2.844929	5.186371	7.330354	2.422779	131.577	228.422	234	2.542159	15.25838	0.167
20	5	4.564496	10.9547	5.477123	2.883938	2.620401	14.66071	1.621079	194.135	165.864	5600	2.542159	0.634523	4
	10	4.53093	10.51154	5.437207	2.843568	2.593185	14.66071	1.694536	189.4	170.59	2800	2.542159	1.270401	2
	20	4.470149	10.72881	5.364179	2.770994	2.593185	14.66071	1.847494	180	180	1400	2.542159	2.542159	1
	50	4.681523	11.23593	5.617737	3.024551	2.593185	14.66071	2.35585	151.51	208.489	560	2.542159	6.357431	0.4
	60	4.777685	11.46681	5.733403	3.1443	2.593185	14.66071	2.542057	141.695	218.304	466.66	2.542159	7.629188	0.34
50	5	12.27783	29.46715	14.73358	13.69666	1.036911	36.65178	2.167128	223.32	136.68	14000	2.542159	0.254216	10
	10	12.25606	29.41453	14.70727	13.6699	1.036911	36.65178	2.227885	218.304	141.7	7000	2.542159	0.508432	5
	20	12.2175	29.322	14.20741	13.89579	1.036911	36.65178	2.35585	208.49	151.51	3500	2.542159	1.016864	2.5
	50	12.14629	29.11925	14.5594	13.52203	1.036911	36.65178	2.790698	180	180	1400	2.542159	2.542159	1
	60	12.15717	29.17731	14.58843	13.55151	1.036911	36.65178	2.949118	170.56	189.404	1167	2.542159	3.050591	0.834
60	5	16.97976	40.75116	20.37807	19.51126	0.864093	43.98214	2.366493	233.631	126.368	16800	2.542159	0.211508	12
	10	16.95708	40.69718	20.34859	19.48404	0.864093	43.98214	2.422779	228.922	131.577	8400	2.542159	0.423015	6
	20	16.91807	40.6042	20.30051	19.43732	0.864093	43.98214	2.542032	218.304	141.685	4200	2.542159	0.847386	3
	50	16.83597	40.40688	20.20344	19.42961	0.864093	43.98214	2.950972	189.4	170.59	1680	2.542159	2.119144	1.2
	60	16.81556	40.35835	20.17895	19.3144	0.864093	43.98214	3.104134	180	180	1400	2.542159	2.542159	1

Table 2 - When RPM of Driving pulley is 1400, Power is 0.5 hp and Center Distance is 36 inches

Pitch Diameter (Driving Shaft) (in Cms)	Pitch Diameter (Driven Shaft) (in Cms)	Initial Tension (in kg)	Bearing Force (in kg)	Maximum Tension (in kg)	Minimum Tension (in kg)	Cyclic Variation (in kg)	Belt Speed (in m/s)	Belt Length (in m)	Wrap Angle (Driving pulley) (in degrees)	Wrap Angle (Driven pulley) (in degrees)	RPM (Driven pulley)	Torque (Driving Shaft) (in N-m)	Torque (Driving Shaft) (in N-m)	Drive Ratio
5	5	10.92113	26.21081	13.10518	2.729263	10.37592	3.664245	1.985823	180	180	1400	2.542159	2.542159	1
	10	11.00278	26.39679	13.19499	2.822249	10.37592	3.664245	2.065071	176.86	183.15	700	2.542159	5.087029	0.5
	20	11.16381	26.79323	13.39639	3.020469	10.37592	3.664245	2.227631	170.589	189.41	350	2.542159	10.17406	0.25
	50	11.76708	28.24109	14.12032	3.744402	10.37592	3.664245	2.748356	151.509	208.49	140	2.542159	25.4365	0.1
	60	12.0152	28.83711	14.41833	4.042412	10.37592	3.664245	2.933141	144.994	215.005	116.637	2.542159	30.52489	0.08
10	5	5.884449	14.12349	7.06152	1.874696	5.186371	7.330354	2.065071	183.134	176.865	2800	2.542159	1.271215	2
	10	5.845894	14.03051	7.015254	1.828429	5.186371	7.330354	2.142846	180	180	1400	2.542159	2.542159	1
	20	5.924819	14.22011	7.110055	1.92323	5.186371	7.330354	2.302764	173.73	186.269	700	2.542159	5.084318	0.5
	50	6.211942	14.90866	7.454331	2.267506	5.186371	7.330354	2.815184	154.731	205.268	280	2.542159	12.71486	0.2
	60	6.328969	15.18989	7.594944	2.40812	5.186371	7.330354	2.996684	148.266	211.733	234	2.542159	15.25838	0.167
20	5	4.53093	10.87441	5.437207	2.843568	2.593185	14.66071	2.227631	189.41	170.589	5600	2.542159	0.635607	4
	10	4.509612	10.82361	5.411806	2.818167	2.593185	14.66071	2.302764	186.269	173.73	2800	2.542159	1.270401	2
	20	4.470149	10.72881	5.364179	2.770994	2.593185	14.66071	2.457094	180	180	1400	2.542159	2.542159	1
	50	4.60033	11.04134	5.520668	2.927483	2.593185	14.66071	2.953004	161.116	198.883	560	2.542159	6.357431	0.4
	60	4.652947	11.16789	5.583718	2.990532	2.593185	14.66071	3.129331	154.731	205.268	467	2.542159	7.629188	0.34
50	5	12.2175	29.322	14.661	13.62364	1.036911	36.65178	2.748356	208.49	151.509	14000	2.542159	0.254216	10
	10	12.20616	29.29479	14.64739	13.61003	1.036911	36.65178	2.815184	205.268	154.731	7000	2.542159	0.508432	5
	20	12.18484	29.24444	14.62199	13.58463	1.036911	36.65178	2.953004	198.883	161.11	3500	2.542159	1.016864	2.5
	50	12.13268	29.11925	14.5594	13.52203	1.036911	36.65178	33803.39	180	180	1400	2.542159	2.542159	1
	60	12.14855	29.15735	14.57845	13.54108	1.036911	36.65178	3.559404	175.73	186.269	1167	2.542159	3.050591	0.834
60	5	16.90673	40.57698	20.28826	19.42372	0.864093	43.98214	2.933141	215.005	144.994	16800	2.542159	0.211508	12
	10	16.8963	40.55158	20.27556	19.41102	0.864093	43.98214	2.997124	211.733	148.266	8400	2.542159	0.423015	6
	20	16.8768	40.5044	20.25198	19.38788	0.864093	43.98214	3.129331	205.268	154.731	4200	2.542159	0.847386	3
	50	16.82917	40.38965	20.19482	19.33028	0.864093	43.98214	3.559404	186.269	173.73	1680	2.542159	2.119144	1.2
	60	16.81556	40.35835	20.17895	19.3144	0.864093	43.98214	3.713734	180	180	1400	2.542159	2.542159	1

Table 3 - When RPM of Driving pulley is 1400, Power is 0.5 hp and Center Distance is 50 inches

Pitch Diameter (Driving Shaft) (in Cms)	Pitch Diameter (Driven Shaft) (in Cms)	Initial Tension (in kg)	Bearing Force (in kg)	Maximum Tension (in kg)	Minimum Tension (in kg)	Cyclic Variation (in kg)	Belt Speed (in m/s)	Belt Length (in m)	Wrap Angle (Driving pulley) (in degrees)	Wrap Angle (Driven pulley) (in degrees)	RPM (Driven pulley)	Torque (Driving Shaft) (in N-m)	Torque (Driving Shaft) (in N-m)	Drive Ratio
5	5	10.92113	26.21081	13.10518	2.729263	10.37592	3.664204	2.697023	180	180	1400	2.542159	2.542159	1
	10	10.97647	26.34372	13.17186	2.795941	10.37592	3.664204	2.776068	177.743	182.256	700	2.542159	5.087029	0.5
	20	11.09259	26.62222	13.31111	2.935194	10.37592	3.664204	2.937104	173.228	186.771	350	2.542159	10.18084	0.25
	50	11.49085	27.57885	13.7892	3.41328	10.37592	3.664204	3.443884	159.59	200.409	140	2.542159	25.4365	0.1
	60	11.64416	27.94626	13.9729	3.596985	10.37592	3.664204	3.62077	154.988	205.011	117	2.542159	30.52489	0.08
10	5	5.871295	14.09673	7.048366	1.859727	5.186371	7.330354	2.776068	182.256	177.743	2800	2.543108	1.270401	2
	10	5.845894	14.03069	7.015254	1.828429	5.186371	7.330354	2.854147	180	180	1400	2.542159	2.542159	1
	20	5.902139	14.16522	7.082385	1.896015	5.186371	7.330354	3.013202	175.487	184.512	700	2.542159	5.084318	0.5
	50	6.094462	14.62743	7.313717	2.126893	5.186371	7.330354	3.514014	161.878	198.121	280	2.542159	12.71486	0.2
	60	6.168398	14.80434	7.402168	2.215343	5.186371	7.330354	3.688918	157.294	202.705	234	2.542159	15.25838	0.167
20	5	4.51324	10.83178	5.415888	2.826785	2.620401	14.66071	2.937104	186.771	173.228	5600	2.542159	0.634523	4
	10	4.498272	10.7964	5.398198	2.804559	2.593185	14.66071	3.013202	184.512	175.487	2800	2.542159	1.270401	2
	20	4.470149	10.72881	5.364179	2.770994	2.593185	14.66071	3.168294	180	180	1400	2.542159	2.542159	1
	50	4.562682	10.94472	5.472134	2.878948	2.593185	14.66071	3.65727	166.433	193.566	560	2.542159	6.357431	0.4
	60	4.594433	11.02728	5.513411	2.920225	2.593185	14.66071	3.828186	161.878	198.121	466.66	2.542159	7.629188	0.34
50	5	12.18983	29.2331	14.62789	13.59052	1.036911	36.65178	3.443884	200.409	159.59	14000	2.542159	0.254216	10
	10	12.18257	29.24761	14.61927	13.58191	1.036911	36.65178	3.514014	198.121	161.878	7000	2.542159	0.508432	5
	20	12.16897	29.20588	14.60294	13.56558	1.036911	36.65178	3.65727	193.566	166.433	3500	2.542159	1.016864	2.5
	50	12.13268	29.11925	14.5594	13.52203	1.036911	36.65178	4.110787	180	180	1400	2.542159	2.542159	1
	60	12.14402	29.14646	14.573	13.53564	1.036911	36.65178	4.269816	175.487	184.512	1167	2.542159	3.050591	0.834
60	5	16.87589	40.50259	20.25107	19.38698	0.864093	43.98214	3.62077	205.011	154.988	16800	2.542159	0.211508	12
	10	16.86954	40.48717	20.24336	19.37881	0.864093	43.98214	3.688918	202.705	157.294	8400	2.542159	0.423015	6
	20	16.85729	40.45768	20.22884	19.3643	0.864093	43.98214	3.828186	198.121	161.878	4200	2.542159	0.847386	3
	50	16.82509	40.38057	20.19029	19.32574	0.864093	43.98214	4.269816	184.512	175.987	1680	2.542159	2.119144	1.2
	60	16.81556	40.35835	20.17895	19.3144	0.864093	43.98214	4.424934	180	180	1400	2.542159	2.542159	1

Table 4 - When RPM of Driving pulley is 1400, Power is 0.5 hp and Center Distance is 60 inches

Pitch Diameter (Driving Shaft) (in Cms)	Pitch Diameter (Driven Shaft) (in Cms)	Initial Tension (in kg)	Bearing Force (in kg)	Maximum Tension (in kg)	Minimum Tension (in kg)	Cyclic Variation (in kg)	Belt Speed (in m/s)	Belt Length (in m)	Wrap Angle (Driving pulley) (in degrees)	Wrap Angle (Driven pulley) (in degrees)	RPM (Driven pulley)	Torque (Driving Shaft) (in N-m)	Torque (Driving Shaft) (in N-m)	Drive Ratio
5	5	10.92113	26.21081	13.10518	2.729263	10.37592	3.664204	3.205023	180	180	1400	2.542159	2.542159	1
	10	10.96649	26.32149	13.16052	2.784601	10.37592	3.664204	3.283991	178.119	181.88	700	2.542159	5.087029	0.5
	20	11.06266	26.55101	13.27528	2.89936	10.37592	3.664204	3.444367	174.357	185.642	350	2.542159	10.18084	0.25
	50	11.38334	27.3203	13.65992	3.284006	10.37592	3.664204	3.945179	163.019	196.98	140	2.542159	25.4365	0.1
	60	11.50309	27.60833	13.82684	3.428248	10.37592	3.664204	4.118737	159.208	200.791	117	2.542159	30.52489	0.08
10	5	5.882635	14.08585	7.042923	1.856098	5.186371	7.330354	3.283991	181.88	178.119	2800	2.543108	1.270401	2
	10	5.845894	14.03051	7.015254	1.828429	5.186371	7.330354	3.362147	180	180	1400	2.542159	2.542159	1
	20	5.892614	14.14254	7.071046	1.884221	5.186371	7.330354	3.520872	176.239	183.76	700	2.542159	5.084318	0.5
	50	6.048196	14.5163	7.257926	2.071555	5.186371	7.330354	4.016756	184.918	195.081	280	2.542159	12.71486	0.2
	60	6.106709	14.65601	7.327779	2.141408	5.186371	7.330354	4.188638	161.116	198.893	234	2.542159	15.25838	0.167
20	5	4.505529	10.81363	5.406817	2.813631	2.620401	14.66071	3.444367	185.642	174.257	5600	2.542159	0.634523	4
	10	4.493282	10.7846	5.392302	2.798663	2.593185	14.66071	3.520872	183.76	176.239	2800	2.542159	1.270401	2
	20	4.470149	10.72881	5.364179	2.770994	2.593185	14.66071	3.676802	180	180	1400	2.542159	2.542159	1
	50	4.544085	10.90571	5.452629	2.859444	2.593185	14.66071	4.162323	168.703	191.296	560	2.542159	6.357431	0.4
	60	4.5713	10.97148	5.485742	2.892556	2.593185	14.66071	4.330903	164.918	195.081	466.66	2.542159	7.629188	0.34
50	5	12.17895	29.23038	14.61519	13.57782	1.036911	36.65178	3.945179	196.98	168.019	14000	2.542159	0.254216	10
	10	11.96712	29.21631	14.60793	13.57057	1.036911	36.65178	4.016756	195.081	164.918	7000	2.542159	0.508432	5
	20	12.16262	29.19001	14.59478	13.55741	1.036911	36.65178	4.162323	191.296	168.703	3500	2.542159	1.016864	2.5
	50	12.13268	29.11925	14.5594	13.52203	1.036911	36.65178	4.618787	180	180	1400	2.542159	2.542159	1
	60	12.1422	29.14147	14.57074	13.53337	1.036911	36.65178	4.777511	176.239	183.76	1167	2.542159	3.050591	0.834
60	5	16.8641	40.47447	20.23701	19.37291	0.864093	43.98214	4.118737	200.791	159.208	16800	2.542159	0.211508	12
	10	16.85911	40.46222	20.23111	19.36656	0.864093	43.98214	4.188638	198.883	161.116	8400	2.542159	0.423015	6
	20	16.84958	40.43909	20.21932	19.35522	0.864093	43.98214	4.330903	195.081	164.918	4200	2.542159	0.847386	3
	50	16.82373	40.37695	20.18847	19.32393	0.864093	43.98214	4.777511	183.75	176.239	1680	2.542159	2.119144	1.2
	60	16.81556	40.35835	20.17895	19.3144	0.864093	43.98214	4.932934	180	180	1400	2.542159	2.542159	1

Table 5 - When RPM of Driving pulley is 1400, Power is 1 hp and Center Distance is 24 inches

Pitch Diameter (Driving Shaft) (in Cms)	Pitch Diameter (Driven Shaft) (in Cms)	Initial Tension (in kg)	Bearing Force (in kg)	Maximum Tension (in kg)	Minimum Tension (in kg)	Cyclic Variation (in kg)	Belt Speed (in m/s)	Belt Length (in m)	Wrap Angle (Driving pulley) (in degrees)	Wrap Angle (Driven pulley) (in degrees)	RPM (Driven pulley)	Torque (Driving Shaft) (in N-m)	Torque (Driving Shaft) (in N-m)	Drive Ratio
5	5	21.73205	52.15673	26.07836	5.326531	20.75183	3.664245	1.376223	180	180	1400	5.085673	5.085673	1
	10	21.96655	52.72009	26.36005	5.608211	20.75183	3.664245	1.455801	175.288	184.701	700	5.085673	10.17406	0.5
	20	22.48592	53.96656	26.98328	6.231447	20.75183	3.664245	1.748104	165.864	194.135	350	5.085673	20.34947	0.25
	50	24.63367	59.12073	29.56014	8.808303	20.75183	3.664245	2.167128	136.679	223.32	140	5.085673	50.87436	0.1
	60	25.66469	61.59553	30.79754	10.0457	20.75183	3.664245	2.366493	126.36	233.631	117	5.085673	61.04977	0.08
10	5	11.36747	27.28174	13.64087	3.267677	20.75183	7.330354	1.455801	184.701	175.298	2800	5.085673	2.542159	2
	10	11.24999	27.00006	13.49981	3.12661	20.75183	7.330354	1.533347	180	180	1400	5.085673	5.085673	1
	20	11.49266	27.58248	13.79101	3.417816	20.75183	7.330354	1.694536	170.59	189.4	700	5.085673	10.17135	0.5
	50	12.47968	29.95159	14.97579	4.602598	20.75183	7.330354	2.227885	141.69	218.3	280	5.085673	25.43108	0.2
	60	12.94415	31.06652	15.53326	5.159609	10.3732	7.330354	2.422779	131.577	228.422	234	5.085673	30.51675	0.167
20	5	7.360437	17.66605	8.832797	3.645972	5.186371	14.66071	1.621104	194.135	165.864	1800	5.085673	1.270401	4
	10	7.293306	17.50457	8.752058	3.565687	5.186371	14.66071	1.694536	189.4	170.59	2800	5.085673	2.542159	2
	20	7.172197	17.00698	8.606455	3.420084	5.186371	14.66071	1.847494	180	180	1400	5.085673	5.085673	1
	50	7.594944	18.2285	9.114024	3.9272	5.186371	14.66071	2.35585	151.51	208.489	560	5.085673	12.71486	0.4
	60	7.787267	18.68935	9.344449	4.158078	5.186371	14.66071	2.542057	141.695	218.304	467	5.085673	15.25838	0.34
50	5	13.50389	32.4096	16.20457	14.12984	5.186371	36.64924	2.167128	223.32	136.68	14000	5.085673	0.508432	10
	10	13.45989	32.30346	16.1515	14.07677	5.186371	36.64924	2.227885	218.304	141.7	7000	5.085673	1.016864	5
	20	13.38278	31.84715	16.05942	14.43829	5.186371	36.64924	2.35585	208.49	151.514	3500	5.085673	2.033727	2.5
	50	13.21359	31.73375	15.62987	13.78194	2.074276	36.64924	2.791206	180	180	1400	5.085673	5.085673	1
	60	13.26212	31.82946	15.91473	13.83546	2.074276	36.64924	2.95115	170.56	189.404	1167	5.085673	6.102537	0.834
60	5	18.04389	43.30624	21.65312	19.92403	2.074276	36.64924	2.366493	233.631	126.368	16800	5.085673	0.423015	12
	10	17.99898	43.19738	21.59869	19.8696	2.074276	36.64924	2.422779	228.922	131.577	8400	5.085673	0.847386	6
	20	17.94864	43.01186	21.5057	19.77706	2.074276	36.64924	2.542032	218.304	141.685	4200	5.085673	1.694773	3
	50	17.75677	42.61678	21.30839	19.5793	1.728639	43.98214	2.95115	189.4	170.59	1680	5.085673	4.238287	1.2
	60	17.7164	42.51971	21.25986	19.53076	1.728639	43.98214	3.104149	180	180	1400	5.085673	5.085673	1

Table 6 - When RPM of Driving pulley is 1400, Power is 1 hp and Center Distance is 36 inches

Pitch Diameter (Driving Shaft) (in Cms)	Pitch Diameter (Driven Shaft) (in Cms)	Initial Tension (in kg)	Bearing Force (in kg)	Maximum Tension (in kg)	Minimum Tension (in kg)	Cyclic Variation (in kg)	Belt Speed (in m/s)	Belt Length (in m)	Wrap Angle (Driving pulley) (in degrees)	Wrap Angle (Driven pulley) (in degrees)	RPM (Driven pulley)	Torque (Driving Shaft) (in N-m)	Torque (Driving Shaft) (in N-m)	Drive Ratio
5	5	21.73205	52.15673	26.07836	5.326531	20.75183	3.664204	1.985823	180	180	1400	5.085673	5.085673	1
	10	21.88672	52.52822	26.26388	5.51205	20.75183	3.664204	2.065071	176.86	183.13	700	5.085673	10.17406	0.5
	20	22.21739	53.32201	26.66078	5.905768	20.75183	3.664204	2.227631	170.589	189.41	350	5.085673	20.34947	0.25
	50	23.42349	56.21366	28.10864	7.356355	20.75183	3.664204	2.748356	151.509	208.49	140	5.085673	50.87436	0.1
	60	23.92063	57.40978	28.70466	7.952829	20.75183	3.664204	2.933141	144.994	215.005	117	5.085673	61.04977	0.08
10	5	11.3271	27.1815	13.59279	3.219596	10.3732	7.330354	2.065071	183.134	176.865	2800	5.085673	2.542159	2
	10	11.24999	27.00006	13.49981	2.763736	10.3732	7.330354	2.142947	180	180	1400	5.085673	5.085673	1
	20	11.40829	27.37972	13.68986	3.316211	10.3732	7.330354	2.302764	173.73	186.269	700	5.085673	10.17135	0.5
	50	11.98163	28.75637	14.37796	4.004764	10.3732	7.330354	2.815184	154.751	205.268	280	5.085673	25.43108	0.2
	60	12.21614	29.31928	14.65964	4.285991	10.3732	7.330354	2.997124	148.26	211.733	234	5.085673	30.51675	0.167
20	5	7.293306	17.50457	8.752058	3.565687	5.186371	14.66071	2.227631	189.41	170.589	5600	5.085673	1.270401	4
	10	7.251122	17.40342	8.701709	3.514884	5.186371	14.66071	2.302764	186.269	173.73	2800	5.085673	2.542159	2
	20	7.172197	17.21336	8.606455	3.420084	5.186371	14.66071	2.457094	180	180	1400	5.085673	5.085673	1
	50	7.433012	17.83886	8.919433	3.732609	5.186371	14.66071	2.953004	161.116	198.883	560	5.085673	12.71486	0.4
	60	7.537792	18.09152	9.045532	3.859161	5.186371	14.66071	3.129331	154.731	205.268	466.66	5.085673	15.25838	0.34
50	5	13.38278	32.1193	16.05942	13.98469	2.074276	36.65178	2.748356	208.49	151.509	14000	5.085673	0.508432	10
	10	13.3601	32.06442	16.03221	13.95748	2.074276	36.65178	2.815184	205.268	154.731	7000	5.085673	1.016864	5
	20	13.31791	31.96327	15.98141	13.90713	2.074276	36.65178	2.953004	198.883	161.11	3500	5.085673	2.033727	2.5
	50	13.21359	31.71334	15.85667	13.78194	2.074276	36.65178	3.399587	180	180	1400	5.085673	5.085673	1
	60	13.24534	31.78909	15.89432	13.81959	2.074276	36.65178	3.559404	173.73	186.269	1167	5.085673	6.102537	0.834
60	5	17.89874	42.95743	21.47849	19.74985	1.728639	43.98214	2.933141	215.005	144.994	16800	5.085673	0.423015	12
	10	17.87742	42.90617	21.45309	19.72399	1.728639	43.98214	2.997124	211.733	148.266	8400	5.085673	0.847386	6
	20	17.83841	42.81228	21.40591	19.67727	1.728639	43.98214	3.129331	205.268	154.731	4200	5.085673	1.694773	3
	50	17.7427	42.58322	21.29161	19.56252	1.728639	43.98214	3.559404	186.269	173.73	1680	5.085673	4.238287	1.2
	60	17.7164	42.51971	20.94234	19.53076	1.728639	43.98214	3.713734	180	180	1400	5.085673	5.085673	1

Table 7 - When RPM of Driving pulley is 1400, Power is 1 hp and Center Distance is 50 inches

Pitch Diameter (Driving Shaft) (in Cms)	Pitch Diameter (Driven Shaft) (in Cms)	Initial Tension (in kg)	Bearing Force (in kg)	Maximum Tension (in kg)	Minimum Tension (in kg)	Cyclic Variation (in kg)	Belt Speed (in m/s)	Belt Length (in m)	Wrap Angle (Driving pulley) (in degrees)	Wrap Angle (Driven pulley) (in degrees)	RPM (Driven pulley)	Torque (Driving Shaft) (in N-m)	Torque (Driving Shaft) (in N-m)	Drive Ratio
5	5	21.73205	52.15673	26.07836	5.326531	20.75183	3.664204	2.697023	180	180	1400	5.085673	5.085673	1
	10	21.84272	52.42253	26.21127	5.459433	20.75183	3.664204	2.774798	177.743	182.256	700	5.085673	10.17406	0.5
	20	22.07496	52.98	26.48977	5.737939	20.75183	3.664204	2.937104	173.228	186.771	350	5.085673	20.34947	0.25
	50	22.87192	54.89234	27.44594	6.694111	20.75183	3.664204	3.443884	159.59	200.409	140	5.085673	50.87436	0.1
	60	23.1781	55.62716	27.81335	7.06152	20.75183	3.664204	3.62077	154.988	205.011	117	5.085673	61.04977	0.08
10	5	11.30533	27.13297	13.56648	3.193288	10.3732	7.330354	2.774798	182.256	177.743	2800	5.085673	2.542159	2
	10	11.24999	27.00006	13.49981	3.12661	10.3732	7.330354	2.854147	180	180	1400	5.085673	5.085673	1
	20	11.36248	27.26995	13.63498	3.26178	10.3732	7.330354	3.013202	175.487	184.512	700	5.085673	10.17135	0.5
	50	11.74713	28.19392	14.09673	3.638216	10.3732	7.330354	3.514014	161.878	198.121	280	5.085673	25.43108	0.2
	60	11.89454	28.54772	14.27363	3.900438	10.3732	7.330354	3.688918	157.244	202.705	234	5.085673	30.51675	0.167
20	5	7.257926	17.41929	8.70942	3.523049	5.186371	14.66071	2.937104	186.771	173.228	5600	5.085673	1.270401	4
	10	7.228442	17.34853	8.67404	3.487669	5.186371	14.66071	3.013202	184.512	175.487	2800	5.085673	2.542159	2
	20	7.172197	17.21336	8.606455	3.420084	5.186371	14.66071	3.168294	180	180	1400	5.085673	5.085673	1
	50	7.352273	17.64609	8.822818	3.635993	5.186371	14.66071	3.65727	166.433	193.566	560	5.085673	12.71486	0.4
	60	7.420765	17.81029	8.904918	3.718547	5.186371	14.66071	3.828186	161.878	198.121	466.66	5.085673	15.25838	0.34
50	5	13.32744	31.98685	15.9932	13.91847	2.074276	36.65178	3.443884	200.409	159.59	14000	5.085673	0.508432	10
	10	13.31338	31.95193	15.97596	13.90123	2.074276	36.65178	3.514014	198.121	181.878	7000	5.085673	1.016864	5
	20	13.28571	31.88616	15.94285	13.86812	2.074276	36.65178	3.65727	193.566	186.433	3500	5.085673	2.033727	2.5
	50	13.21359	31.71334	15.85667	13.78194	2.074276	36.65178	4.110787	180	180	1400	5.085673	5.085673	1
	60	13.23627	31.76732	15.88343	13.8087	2.074276	36.65178	4.269816	175.487	184.512	1167	5.085673	6.102537	0.834
60	5	17.83705	42.80911	21.40455	19.67546	1.728639	43.98214	3.62077	205.011	154.988	16800	5.085673	0.423015	12
	10	17.8239	42.77781	21.38868	19.66004	1.728639	43.98214	3.688918	202.705	157.294	8400	5.085673	0.847386	6
	20	17.7994	42.71884	21.35919	19.63055	1.728639	43.98214	3.828186	198.121	161.878	4200	5.085673	1.694773	3
	50	17.73499	42.56462	21.28208	19.55344	1.728639	43.98214	4.269816	184.512	175.487	1680	5.085673	4.238287	1.2
	60	17.7164	42.51971	21.25986	19.53076	1.728639	43.98214	4.424934	180	180	1400	5.085673	5.085673	1

Table 8 - When RPM of Driving pulley is 1400, Power is 1 hp and Center Distance is 60 inches

Pitch Diameter (Driving Shaft) (in Cms)	Pitch Diameter (Driven Shaft) (in Cms)	Initial Tension (in kg)	Bearing Force (in kg)	Maximum Tension (in kg)	Minimum Tension (in kg)	Cyclic Variation (in kg)	Belt Speed (in m/s)	Belt Length (in m)	Wrap Angle (Driving pulley) (in degrees)	Wrap Angle (Driven pulley) (in degrees)	RPM (Driven pulley)	Torque (Driving Shaft) (in N-m)	Torque (Driving Shaft) (in N-m)	Drive Ratio
5	5	21.73205	52.15673	26.07836	5.326531	20.75183	3.664245	3.205023	180	180	1400	5.085673	5.085673	1
	10	21.82413	52.37763	26.18859	5.436754	20.75183	3.664245	3.283991	178.119	181.88	700	5.085673	10.17406	0.5
	20	22.01554	52.83712	26.41856	5.666725	20.75183	3.664245	3.444367	174.357	185.642	350	5.085673	20.34947	0.25
	50	22.65647	54.37616	27.18785	6.436017	20.75183	3.664245	3.945179	163.019	196.98	140	5.085673	50.87436	0.1
	60	22.89642	54.95176	27.47588	6.723594	20.75183	3.664245	4.118737	159.208	200.791	117	5.085673	61.04977	0.08
10	5	11.2958	27.11029	13.55514	3.181948	10.3732	7.330354	3.283991	181.88	178.119	2800	5.085673	2.542159	2
	10	11.24999	27.00006	13.49981	3.12661	10.3732	7.330354	3.362147	180	180	1400	5.085673	5.085673	1
	20	11.34298	27.22414	13.61184	3.238647	10.3732	7.330354	3.520872	176.239	183.76	700	5.085673	10.17135	0.5
	50	11.65505	27.97211	13.98606	3.612407	10.3732	7.330354	4.016756	164.918	195.081	280	5.085673	25.43108	0.2
	60	11.77117	28.25107	14.12531	3.752113	10.3732	7.330354	4.188638	161.116	198.883	234	5.085673	30.51675	0.167
20	5	7.242957	17.38346	8.69173	3.504905	5.186371	14.66071	3.444367	185.642	174.357	5600	5.085673	1.270401	4
	10	7.218917	17.32540	8.6627	3.475875	5.186371	14.66071	3.520872	183.76	176.239	2800	5.085673	2.542159	2
	20	7.172197	17.21336	8.606455	3.420084	5.186371	14.66071	3.676294	180	180	1400	5.085673	5.085673	1
	50	7.319614	17.56762	8.783809	3.596985	5.186371	14.66071	4.162323	168.703	191.296	560	5.085673	12.71486	0.4
	60	7.374499	17.69961	8.84958	3.662755	5.186371	14.66071	4.330903	164.918	195.081	467	5.085673	15.25838	0.34
50	5	13.30612	31.93514	15.96735	13.89262	2.074276	36.65178	3.945179	196.98	163.091	14000	5.085673	0.508432	10
	10	13.29478	31.90748	15.95374	13.87901	2.074276	36.65178	4.016756	195.081	164.918	7000	5.085673	1.016864	5
	20	13.27256	31.85486	15.92743	13.8527	2.074276	36.65178	4.162323	191.296	168.703	3500	5.085673	2.033727	2.5
	50	13.21359	31.71334	15.85667	13.78194	2.074276	36.65178	4.618787	180	180	1400	5.085673	5.085673	1
	60	13.23219	31.75779	15.8789	13.80417	2.074276	36.65178	4.777511	176.239	183.76	1167	5.085673	6.102537	0.834
60	5	17.81347	42.75241	21.37598	19.64734	1.728639	43.98214	4.118737	200.791	159.208	18800	5.085673	0.423015	12
	10	17.80349	42.72837	21.36418	19.63509	1.728639	43.98214	4.188638	198.883	161.116	8400	5.085673	0.847386	6
	20	17.78398	42.68165	21.3406	19.61196	1.728639	43.98214	4.330903	195.081	164.918	4200	5.085673	1.694773	3
	50	17.73182	42.55691	21.27845	19.54936	1.728639	43.98214	4.777511	183.76	176.239	1680	5.085673	4.23422	1.2
	60	17.7164	42.51971	21.25986	19.53076	1.728639	43.98214	4.932934	180	180	1400	5.085673	5.085673	1

Experimental Setup:

Figure 3. General Overview of Test Rig

This setup is fabricated, knowing the requirements of the experiment and considering the flexibility needed. It can be employed to practically demonstrate the effect of power transmission. Direct calculation of variation in RPMs is possible. This test rig can be employed for center distance varying from 12 inches to 72 inches.

Characteristics of test rig:

- Flexible horizontal and vertical movement of driven shaft.
- Pulley of variable diameter can be used.
- Center distance is changeable.
- Simple procedure of analysis.

III. RESULTS AND DISCUSSION

It has been observed that, the compilation of the database in this form is possible and be fruitful for the designing of belt drives. It must also be noted that any databook do have analytically calculated data and there is always room for variation from actual practical experiment. Even in this research, it has been found that various factors enlighten some errors in the readings. Although the values having room for minute errors, still that comes under safe design due to design consideration parameters.

IV. CONCLUSION

It has been observed that, the compilation of the database in this form is possible and be fruitful for the designing of belt drives. Following important concluding points came out regarding effects of power transmission after deeply analyzing the report;

- Tension in belt gets reduced, while the drive operates. That suggests, elongation takes place in rotational motion. Thus, it must affect the center distance; center distance should be increased by a minimal so that slip phenomenon can be controlled.
- Initial tension and bearing load would be minimum, when the drive ratio is one (1).
- Belt speed and cyclic variation are independent of diameters of pulleys.

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