British Journal of Mathematics & Computer Science
6(4): 307-335, 2015, Article no.BJMCS.2015.081
ISSN: 2231-0851

SCIENCEDOMAIN *international*
www.sciencedomain.org

Computer Aided System for Database Chain Drive Design and Drafting

B. O. Akinnuli[1*] and O. O. Ojo[1*]

[1]*Department of Mechanical Engineering, Federal University of Technology, P.M.B. 704, Akure, Ondo State, Nigeria.*

Article Information

DOI: 10.9734/BJMCS/2015/14188
Editor(s):
(1) Jaime Rangel-Mondragon, Queretaro´s Institute of Technology, Mexico and Autonomous University of Querétaro, Mexico.
Reviewers:
(1) Anonymous, Uganda.
(2) Anonymous, India.
(3) Anonymous, Nigeria.
Complete Peer review History: http://www.sciencedomain.org/review-history.php?iid=734&id=6&aid=7676

Original Research Article

Received: 22 September 2014
Accepted: 04 November 2014
Published: 09 January 2015

Abstract

The study reviewed the procedure involved in the design of chain drive in mechanical system. Machine design and its fabrication hardly do without chain drive system. It involved some calculations using some mathematical model. Frequently, computation makes the designing procedure time consuming, drudgery and error does occur. To avoid drudgery in calculations, save time and make computation errors reduced, software with database was developed for all computations required in chain drive system. This study serves as aid to designers and teaching aids to learners of chain drive system in machine design. The programming language used was C – sharp which was tested using questions and illustrative example picked from a standard textbook and journal. The performance of the developed model was found satisfactory, capable of calculating all parameters required in chain drive system. These calculated design values were used to draft the system for factory production.

Keywords: Software development, database, chain drive, design, drafting.

1 Introduction

The development of database software for chain drive is a computer integrated design that helps to analyze and calculate each parameter required in chain drive [1]. [1] also stress that the chain drive is one of the many parts of machine element and they are usually manufactured using high strength steel and for this reason, it is capable of transmitting high torque. The chains are made up

*Corresponding author: ifembola@yahoo.com, seuntuma@gmail.com;

of number of rigid links which are hinged together by pin joints in order to provide the necessary flexibility for wrapping round the driving and driven wheels. They are often narrower than belts, and this can make it easier to shift them to larger or smaller gears in order to vary the gear ratio. Also, the more positive meshing of a chain can make it easier to build gears that can increase or shrink in diameter, again altering the gear ratio [2].

Lubrecht and Dalmaz [3], state that chains are mostly used to transmit motion and power from one shaft to another, when the centre distance between their shafts is short such as in bicycles, motor cycles, agricultural machinery, conveyors, rolling mills, road rollers etc. The chains may also be used for long centre distance of up to 8 meters. The terms frequently used in chain drive are chain which is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle, particularly bicycle and motorcycle is also in a wide variety of machines besides vehicle, sprocket is a tooth wheel which is designed to engage with chain which will pulled over the wheel as the wheel rotates., and pitch of chain is the hinge centre the distance between a link and the corresponding hinge centre of the adjacent link. It is usually denoted by "p", [4]. If the chain is not being used for a high wear application (for instance if it is just transmitting motion from a hand operated lever to a control shaft on a machine, or a sliding door on an oven), then one of the simpler types of chain may still be used, as stated by [5]. Conversely, where extra strength but the smooth drive of a smaller pitch is required, the chain may be "siamesed", instead of just two rows of plates on the outer sides of the chain, there may be three ("duplex"), four ("triplex"), or more rows of plates running parallel with bushings and rollers between each adjacent pair, and the same number of rows of teeth running in parallel on the sprockets to match [6].

The oldest known application of a chain drive appears in the polybolos, a repeating crossbow described by the Greek Engineer Phil of Byzantium. Two flat – linked chains were connected to a windlass, which by winding back and forth would automatically fire the machine's arrows until its magazine was empty [7]. Although, the device did not transmit power continuously since the chains did not transmit power from shaft to shaft [8]. The Greek design marks the beginning of the history of the chain drive since "no earlier instance of such a cam is known, and none as complex is known until the 16th century. It is here that the flat – link chain, often attributed to Leonardo da Vinci, actually made its first appearance. The first continuous power – transmitting chain drive was depicted in the written horological treatise of the song Dynasty (960 – 1279) Chinese engineer Su Song (1020 – 1101AD), who used it to operate the armillary sphere of its astronomical clock tower as well as the clock jack figurines presenting the time of day by mechanically banging gongs and drums [9]. The chain drive itself was given power via the hydraulic works of Su's water clock tank and waterwheel, the latter which acted as a large gear. The endless power – transmitting chain drive was invented separately in Europe by Jacques de Vaucanson first in 1770 for a silk reeling and throwing mill [10].

Chain drive was the main feature which differentiated the safely bicycle introduced in 1885, with its two equal – sized wheels, from the direct – drive penny – farthing or "high wheeler" type of bicycle. The popularity of the chain – driven safety bicycle brought about the demise of the penny – farthing, and is still a basic feature of bicycle design today [11]. A chain – drive system uses one or more roller chains to transmit power from a differential to the rear axle. This system allowed for a great deal of vertical axle movement (for example, over bumps), and was simpler to design and build than a rigid driveshaft in a workable suspension. Also, it had less unsprung weight at the rear wheels than the Hotchkiss drive, which would have had the weight of the driveshaft and differential to carry as well. This meant that the vehicle would have a smoother ride. The lighter unsprung mass would allow the suspension to react to bumps more effectively [12].

Power transmitting chains are used for transmission of power, when the distance between the centres of shafts is short. These chains have provision for efficient lubrication. The power transmitting chains are of block or bush chain, bush roller chain and silent chain. The block or bush chain was used in the early stages of development in the power transmission. It produces noise when approaching or leaving the teeth of the sprocket because of rubbing between the teeth and the links. Such types of chains are used to some extent as conveyor chain at small speed, while the bush and roller chain consists of outer plates or pin link plates, inner plates or roller link plates, pins, bushes and rollers. A pin passes through the bush which is secured in the holes of the roller between the two sides of the chain. And a silent chain (also known as inverted tooth chain), is designed to eliminate the evil effects caused by stretching and to produce noiseless running [13].

When the chain stretches and the pitch of the chain increases, the links ride on the teeth of the sprocket wheel at a slightly increased radius. This automatically corrects the small change in the pitch. There is no relative sliding between the teeth of the inverted tooth chain and the sprocket wheel teeth. When properly lubricated, this chain gives durable service and runs very smoothly and quietly [14]. This study made the design of chain speedy with the aid of computer system, drudgery and error in computation was reduced, increased the productivity of the designer by reducing the time required for the designer to synthesize, analyze and document the design, a computer – aided design (CAD) system which was used with appropriate hardware and software capabilities permitted the designer to do more complete engineering analysis and to consider a large number and variety of design alternative thereby improving the quality of the resulting design.

2 Methodology

This study identified the design parameters required for chain drives, collect data required, applied the mathematical model that is appropriate, developed the software for computation and drafting of the chain drive and tested the developed software for performance evaluation.

The method used to meet the set objectives in this study includes reviewing the different theories of failure in order to identify the appropriate method and design equation that could be used for chain drive design. This was followed by the compilation and analysis of the procedure that was used for determination of the different parameters that went into the design equation so as to be able to develop generalized mathematical algorithms for the solution of different problems. This was done by consulting different standard textbooks and internet. The resulted algorithms were coded into user – friendly computer software which was automatically design and draw the chain drive system based on minimum specification of input pitch speed and parameter of loading members. The software language used was C – sharp programming language. Modularity made the program easier to understand and allowed modules that contained standard procedure was reused throughout the software thereby saving space, time and made tracing of mistakes and errors easier. The software was tested using illustrative example selected from standard textbooks and the results were compared with that of longhand calculation values to ascertain validity of the developed software.

2.1 Model Development

The following mathematical models were used for chain drives design and their parameters designed for as well as symbol and their explanation hereby stated below:

i. Chain distance between the two sprockets, C;

$$C = \frac{1}{4}\left[L - \frac{N_1 + N_2}{2} + \sqrt{\left(L - \frac{N_1 + N_2}{2}\right) - \frac{8(N_2 - N_1)^2}{4\pi^2}}\right]$$

L = chain length
N_2 = number of teeth on the larger sprocket
N_1 = number of teeth on the small sprocket

ii. Chain Length, L

$L = 2C + \frac{N_1+N_2}{2} + \frac{(N_2-N_1)^2}{4\pi^2 C}$
C = chain distance between the two sprockets
N_2 = number of teeth on the larger sprocket
N_1 = number of teeth on the small sprocket

iii. Transmission, i

$i = \frac{z_1}{z_2} = \frac{n_2}{n_1}$
Where z_2 = number of teeth on large sprocket
z_1 = number of teeth on small sprocket
n_2 = speed of the large sprocket
n_1 = speed of the small sprocket

iv. Pitch diameter of the Sprocket, D, $D = \frac{P}{\frac{\sin\pi}{N}}$

N = number of the sprocket
P = pitch

v. Chain Speed, V,

$V = \frac{\pi n D}{12}$
n = speed of the sprocket
D = pitch diameter

2.2 Procedure for Design of Chain Drive Using Data (The Data are in Tables 1-13c Shown in Appendix)

The following are the procedures for design of chain drive:

a) **Select the pitch of the chain (roller/bush) number iso/Din and Rolon number from Table 1 – 3**
b) **Specification of the chain selected will generate some value from the Table 1 – 3**
c) **Determine the sprocket diameter**
$d_1 = \frac{P}{\sin\frac{180}{z_1}}$, $d_2 = \frac{P}{\sin\frac{180}{z_2}}$
d) **Determine the power transmitted since the pinion and factor of safety is being selected from the Table 10**
   i. Service factor,
$$K_s = k_1 \cdot k_2 \cdot k_3 \cdot k_4 \cdot k_5 \cdot k_6$$
   ii. Bearing load, $N = \frac{Q \cdot V}{102nk_s}$
   iii. Allowable bearing stresses, $N = \frac{\sigma \cdot A \cdot V}{102k_s}$ where, $V = \pi d_1 n$
e) **Check for the actual factor of safety from Table 11 – 12**
   i. Tension due to the sagging of the chain,
$P_s = k \cdot w \cdot a$ where, $a = 30p$
   ii. Centrifugal tension, $P_c = \frac{wv^2}{g}$
   iii. Tangential force due to the power transmitted, $P_t = \frac{102N}{V}$
$\sum P_{(0,86)kw} = P_t + P_c + P_s$
$\sum P_{(6.98\times10^{-5})kw} = P_t + P_c + P_s$

iv. $[n]_{(0.86)kw} = \frac{Q}{\sum \boldsymbol{p}}$ $\quad [n] > n$

$$[n]_{(6.98\times10^{-5})kw} = \frac{Q}{\sum p}$$

f) Determine the number of stranded required from Table 8

g) Determine the number of teeth for the small sprocket (pinion), $\boldsymbol{n_2 = \frac{n_1 z_1}{z_2}}$ **Table 4 – 5**

h) Determine the tip diameter of the sprocket, $\boldsymbol{d_{a1} = \frac{P}{\tan\frac{180}{z}} + 0.6p}$

i) Calculate the transmission ratio, $\boldsymbol{i = \frac{n_1}{n_2}}$

j) Determine the centre distance of the sprockets from Table 6 and 8

$a_{min} = 1.3a^1 \qquad a^1 = \frac{d_{a1}+d_{a2}}{2}$

$a_{max} = 80_p$

Assume centre distance, $a_p = (30\ to\ 50)p$

Appropriate centre distance, $a_p = \frac{a_0}{p}$

k) The length of the continuous chain,
$\boldsymbol{L_p}$ **from Table 9**

a. $\boldsymbol{l_p = 2a_p + \frac{z_1+z_2}{2} + \frac{\left(\frac{z_2-z_1}{2\pi}\right)^2}{a_p}}$

b. The final centre distance, $\boldsymbol{a = \rho + \sqrt{\frac{\rho^2-8m}{4}} \cdot p}$ **where,** $\boldsymbol{\rho = l_p - \frac{z_2+z_1}{2}}$**,** $\boldsymbol{m = \frac{z_2-z_1}{2\pi}}$

c. The final length of the chain L
$\boldsymbol{L = l_p \cdot P}$

d. The centre distance (decrement) allowable to accommodate initial chain sag
$\Delta = \frac{1}{2}\left[\boldsymbol{f} - \left(\frac{z_2-z_1}{2\pi\pi a_p}\right)^2 \boldsymbol{P}\right]$

l) The load on the shaft due to chain drive, $\boldsymbol{Q_o = K_l \cdot P_t}$

The Logic (flow chart) for the models integration and computation is as shown in Fig. 1.

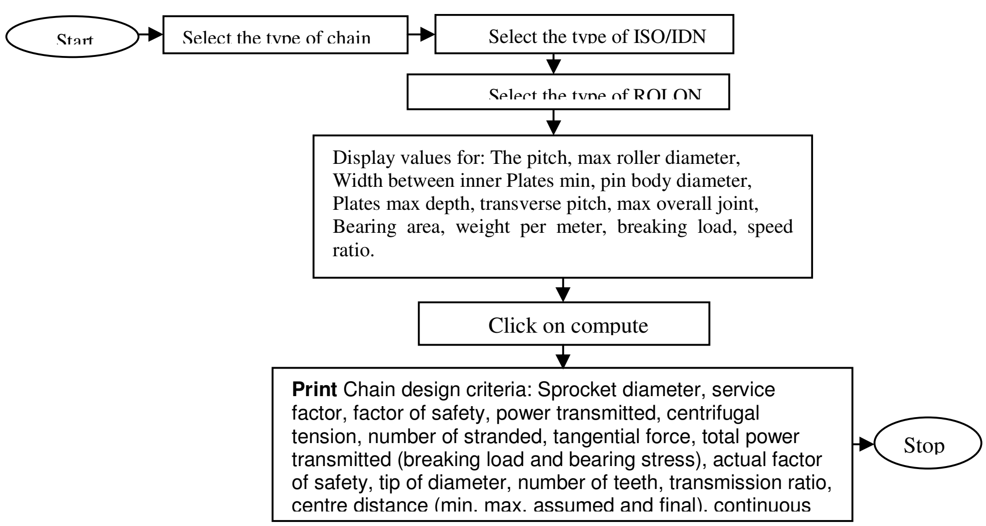


Fig. 1. Flow chart of design chain drive

2.3 Manual Application of Design Data Used

a. Select the pitch of the chain (roller/bush) number iso/Din and Rollon number from Tables 1 – 3
b. Specification of the chain selected will generate some value from the table Pg 1 – 3
c. Determine the sprocket diameter
   $d_1 = \frac{P}{sin\frac{180}{z_1}}$ $d_2 = \frac{P}{sin\frac{180}{z_2}}$
d. Determine the power transmitted since the pinion and factor of safety is being selected from the Table 10
   i. Service factor, $K_s = k_1 \cdot k_2 \cdot k_3 \cdot k_4 \cdot k_5 \cdot k_6$
   ii. Bearing load, $N = \frac{Q.V}{102nk_s}$
   iii. Allowable bearing stresses, $N = \frac{\sigma.A.V}{102k_s}$
   where $V = \pi d_1 n$
e. Check for the actual factor of safety from Tables 11 – 12
   i. tension due to the sagging of the chain, $P_s = k.w.a$
   where, $a = 30p$
   ii. centrifugal tension, $P_c = \frac{wv^2}{g}$
   iii. tangential force due to the power transmitted, $P_t = \frac{102N}{V}$
   $\sum P_{(0.86)kw} = P_t + P_c + P_s$
   $\sum P_{(6.98\times10^{-5})kw} = P_t + P_c + P_s$
   iv. $[n]_{(0.86)kw} = \frac{Q}{\sum p}$ [n]>n
   v. $[n]_{(6.98\times10^{-5})kw} = \frac{Q}{\sum p}$
f. Determine the number of stranded required from Table 8
g. Determine the number of teeth for the small sprocket (pinion),
   $n_2 = \frac{n_1 z_1}{z_2}$ Tables 4 – 5
h. Determine the tip diameter of the sprocket,
   $d_{a1} = \frac{P}{tan\frac{180}{z}} + 0.6p$
i. Calculate the transmission ratio, $i = \frac{n_1}{n_2}$
j. Determine the centre distance of the sprockets from Tables 6 and 8
   $a_{min} = 1.3a^1,$ $a^1 = \frac{d_{a1+}d_{a2}}{2}$
   $a_{max} = 80_p,$

$Assume\ centre\ distance, a_0 = (30\ to\ 50)p$
$Appropriate\ centre\ distance, a_p = \frac{a_0}{p}$

k. The length of the continuous chain, L_p from Table 9
   i. $l_p = 2a_p + \frac{z_1+z_2}{2} + \frac{(\frac{z_2-z_1}{2\pi})^2}{a_p}$
   ii. The final centre distance, $a = \rho + \sqrt{\frac{\rho^2-8m}{4}}$.p
   Where,$\rho = l_p - \frac{z_1+z_2}{2}$ $m = \frac{z_2-z_1}{2\pi}$
   iii. The final length of the chain, L
   $L = l_p.P$
   iv. The centre distance (decrement) allowable to accommodate initial chain sag
   $\Delta = \frac{1}{2}\left[f - \left(\frac{z_2-z_1}{2\pi\pi a_p}\right)^2 P\right]$
l. The load on the shaft due to chain drive, $Q_o = K_l.P_t$

2.4 Chain Drive Design Calculation

1. The selected chain pitch (9.525 mm) of chain type number iso/Din→ $06B{\sim}3$, Rolon from the Tables 1 – 3
2. The specification of the chain selected; $06B{\sim}3$, Rolon TR957 Tables 1 – 3

   a) The pitch, P= 9.525 mm
   b) The maximum roller diameter, D_r = 6.35 mm
   c) The width between inner plate, W = 5.90 mm
   d) Pin body diameter, D_p = 3.28 mm
   e) The plate maximum depth, C_1 = 8.15 mm
   f) The transverse pitch, P_t =10.24 m
   g) Maximum overall joint, $A_1A_2A_3$ = 36.60 mm
   h) Bearing Area = 0.84cm^2
   i) Weight per metre =1.09kgf
   j) The bearing load = 2540kgf
   k) The speed ratio, i = 3.15;

Selected $z_1 = 23$, with speed ratio, i of 3.15

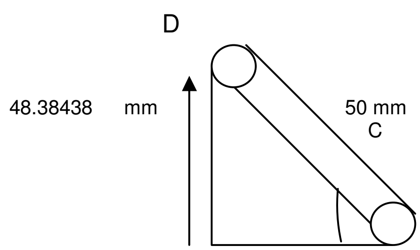
$$z_2 = iz_1 = 3.15(23)$$
$$= 72.45$$

Therefore, $z_1 = 23mm$ and $z_2 = 72mm$

3. The Sprocket diameter;

$$d_1 = \frac{P}{sin\frac{180}{z_1}} \qquad d_2 = \frac{P}{sin\frac{180}{z_2}}$$
$$d_1 = \frac{9.525}{sin\frac{180}{23}} \qquad d_2 = \frac{9.525}{sin\frac{180}{72.45}}$$
$$d_1 = \frac{9.525}{0.1361666} \qquad d_2 = \frac{9.525}{0.0433186}$$
$$d_1 = 69.951074 \; d_2 = 219.882$$
$$d_1 = 70.00mm \quad d_2 = 220.00mm$$

a) The angle of inclination of the chain drive



$$Sin\,\theta = \frac{48.38438}{50}$$
$$\theta = sin^{-1}\left(\frac{48.38438}{50}\right)$$
$$\theta = sin^{-1}(0.9676876)$$
$$\theta = 75.395098$$
$$\theta = 75^{\circ}$$

3 Results and Discussion

After the development of the model required and its application using collected data from a standard textbooks and journals, the model gives better accuracy in the process of computation of data. This software made it easy to carryout design and it reduced time consuming when designing and error free.

Table 1. Summary of the selection of roller and bush chains

	Chain design inputs		**Chain design criteria**		
	Types of chain		**Types of chain**		
	Roller chain ISO/DIN 06B~3 Rolon TR957	**Bush chain ISO/DIN 04C-1**		**Roller chain**	**Bush chain**
i) Pitch ii) Roller diameter Maximum iii) Width between inner plates Minimum iv) Pin body diameter Maximum v) Plate Depth Maximum vi) Transverse pitch vii) Overall Joint Maximum viii) Bearing Area ix) Weight per meter x) Bearing load	9.525 mm 6.35 mm 5.90 mm 3.28 mm 8.15 mm 10.24 mm 36.7 mm 0.84 cm^2 1.09 kgf 2540 kgf	6.35 mm 3.3 mm 3.18 mm 2.31 mm 5.75 mm 0 11.6 mm 0.11 cm^2 0.14 kgf 350 kgf	i) Sprocket diameter D_1(mm), D_2(mm) ii) Service Factor/Safety Factor iii) Power Transmitted Bearing Load (kW)/ Bearing Stress (kW) iv) Centrifugal Tension (kgf)/ Number of Strands v) Tangential Force for: Bearing Load (kgf)/ Bearing Stress (kgf) vi) Total Power Transmitted Bearing Load (kgf)/ Bearing Stress (kgf) vii) Actual Factor of Safety Bearing load/ Bearing stress viii) Tip Diameter(Sprocket) Tip 1/Tip 2 ix) Number of Teeth(Pinion)/ Transmission Ratio x) Centre Distance Min/Max: Assumed/Final: Decrement/Appropriate: xi) Continuous Chain Length/Shaft Load: xii) Speed of the Chain:	70,220 2.344,7.67 0.887,0.0000721 0.0455,3 141.3,0.0115 141.96,0.6799 17.89,3735.66 75.005,225.21 55.95,3.15 195.14,762 285.75,360.05 0.236,30 109.79,148.36 176.27	47,147 2.344,7.67 0.082,0.0000063 0.0026,3 19.470,0.00150 19.526,0.0575 17.925,6088.74 50.004,150.140 55.95,3.14999 130.09,508 190.5,260.724 0.1139,30 109.79,20.44 176.27

3.1 Software Application Results

The software was tested by selecting two types of chains A and B and their interface are as shown in Figs. 2 and 3.

3.1.1 Selected chain A (roller chain)

The roller chain type was selected with the chain design inputs of: type (Roller chain); and Number 06B-3 Rolon (TR957); and compute was clicked. The chain designed criteria are as shown in Fig. 2 below.

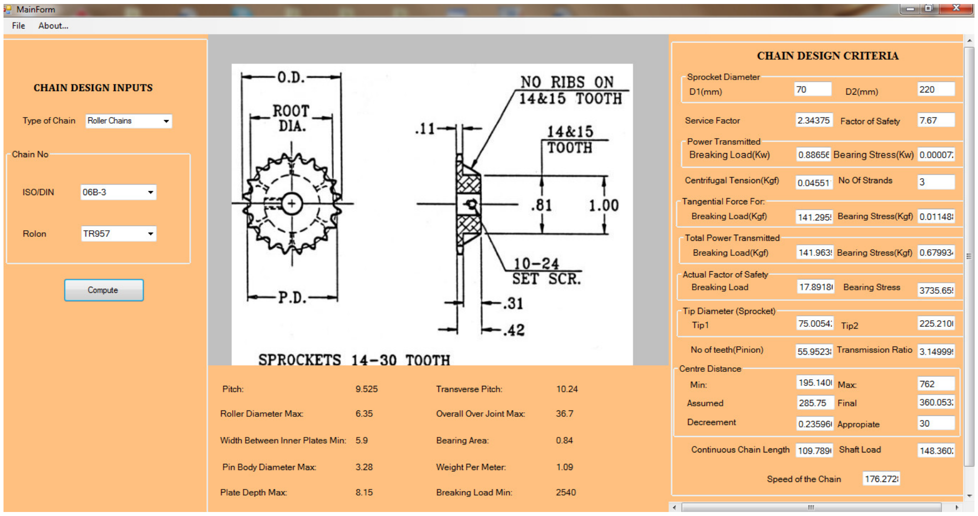


Fig. 2. Interface for chain type a selection (roller chain)

3.1.2 Selected chain B (bush chain)

The chain type Bush chain was selected and the design inputs of: type (Bush chain); and Number (B25) and compute was checked. The chain design criteria values are as shown in the integer below.

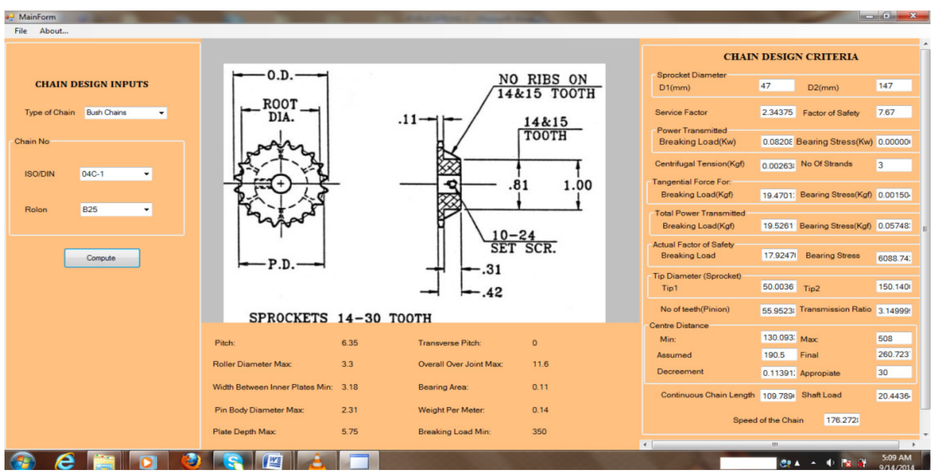


Fig. 3. Interface for chain B (bush chain)

The software was tested by using the illustrative examples and it was found to be accurate and reliable. The efficiency of the software was tried and analyzed by giving the same problem in the illustrative example to different people to solve with the entire necessary tables at their disposal.

And the software was tested with examples which run accurately in line with the manual computation, which made software to save and error free from the design. The objective of this study was achieved by algorithm software system developed that could be used for fast design of chain drive.

3.2 Algorithm Pseudo Code Used

```
usingSystem;
usingSystem.Collections.Generic;
usingSystem.Linq;
usingSystem.Windows.Forms;
namespaceChaindriveSoftware
{
staticclassProgram
   {
       ///<summary>
      ///The main entry point for the application.
      ///</summary>
     [STAThread]
static void Main()
      {
Application.EnableVisualStyles();
Application.SetCompatibleTextRenderingDefault(false);
Application.Run(new Form3());
       }
   }
}
namespaceChaindriveSoftware
{
partial class Form3
  {
    ///<summary>
   ///Required designer variable.
   ///</summary>
Private System. Component Model. I Container components = null;

       ///<summary>
      /// Clean up any resources being used.
       ///</summary>
      ///<param name="disposing">true if managed resources should be disposed; otherwise,

false.</param>

protected override void Dispose(bool disposing)
      {
if (disposing && (components != null))
           {
components.Dispose();
           }
base.Dispose(disposing);
     }
     #region Windows Form Designer generated code

     ///<summary>
```

```
    /// Required method for Designer support – do not modify
/// the contents of this method with the code editor.
    ///</summary>
private void InitializeComponent()
     {
       this.chainSpecDataSet1 = new ChaindriveSoftware.ChainSpecDataSet();
       this.rolonSpecsTableAdapter1 = new
ChaindriveSoftware.ChainSpecDataSetTableAdapters.RolonSpecsTableAdapter();
       this.comboBox1 = new System.Windows.Forms.ComboBox();
       this.comboBox2 = new System.Windows.Forms.ComboBox();
       this.isoDinTableAdapter1 = new
ChaindriveSoftware.ChainSpecDataSetTableAdapters.IsoDinTableAdapter();
       this.comboBox3 = new System.Windows.Forms.ComboBox();
       this.chainTypeTableAdapter1 = new
ChaindriveSoftware.ChainSpecDataSetTableAdapters.ChainTypeTableAdapter();
       this.label1 = new System.Windows.Forms.Label();
       this.button1 = new System.Windows.Forms.Button();
       this.label2 = new System.Windows.Forms.Label();
       ((System.ComponentModel.ISupportInitialize)(this.chainSpecDataSet1)).BeginInit();
this.SuspendLayout();
       //
       // chainSpecDataSet1
       //
       this.chainSpecDataSet1.DataSetName = “ChainSpecDataSet”;
       this.chainSpecDataSet1.SchemaSerializationMode =
System.Data.SchemaSerializationMode.IncludeSchema;
       //
       // rolonSpecsTableAdapter1
       //
       this.rolonSpecsTableAdapter1.ClearBeforeFill = true;
       //
       // comboBox1
       //
       this.comboBox1.DataSource = this.chainSpecDataSet1;
       this.comboBox1.DisplayMember =
“ChainType.FK_IsoDin_ChainType.FK_RolonSpecs_IsoDin.Rolon”;
       this.comboBox1.FormattingEnabled = true;
       this.comboBox1.Location = new System.Drawing.Point(25,117);
       this.comboBox1.Name = “comboBox1”;
       this.comboBox1.Size = new System.Drawing.Size(146,21);
       this.comboBox1.TabIndex = 2;
       this.comboBox1.ValueMember =
“ChainType.FK_IsoDin_ChainType.FK_RolonSpecs_IsoDin.id”;
       This.comboBox1.SelectedIndexChanged += new
System.EventHandler(this.comboBox1_SelectedIndexChanged);
       //
       // comboBox2
       //
       this.comboBox2.DataSource = this.chainSpecDataSet1;
       this.comboBox2.DisplayMember = “ChainType.FK_IsoDin_ChainType.Number”;
       this.comboBox2.FormattingEnabled = true;
       this.comboBox2.Location = new System.Drawing.Point(25, 90);
       this.comboBox2.Name = “comboBox2”;
       this.comboBox2.Size = new System.Drawing.Size(146, 21);
```

```
this.comboBox2.TabIndex = 4;
this.comboBox2.ValueMember = "ChainType.FK_IsoDin_ChainType.id";
//
// isoDinTableAdapter1
//
this.isoDinTableAdapter1.ClearBeforeFill = true;
//
// comboBox3
//
this.comboBox3.DataSource = this.chainSpecDataSet1;
this.comboBox3.DisplayMember = "ChainType.Type";
this.comboBox3.FormattingEnabled = true;
this.comboBox3.Location = new System.Drawing.Point(25, 63);
this.comboBox3.Name = "comboBox3";
this.comboBox3.Size = new System.Drawing.Size(144, 21);
this.comboBox3.TabIndex = 5;
this.comboBox3.ValueMember = "ChainType.id";
//
// chainTypeTableAdapter1
//
this.chainTypeTableAdapter1.ClearBeforeFill = true;
//
// label 1
//
this.label1.AutoSize = true;
this.label1.DataBindings.Add(new
System.Windows.Forms.Binding("Text",this.chainSpecDataSet1,
"ChainType.FK_IsoDin_ChainType.FK_RolonSpecs_IsoDin.Pitch", true));
this.label1.Location = new System.Drawing.Point(40, 173);
this.label1.Name = "label1";
this.label1.Size = new System.Drawing.Size(35, 13);
this.label1.TabIndex = 6;
this.label1.Text = "label1";
//
// button1
//
this.button1.Location = new System.Drawing.Point(44, 223);
this.button1.Name = "button1";
this.button1.Size = new System.Drawing.Size(66, 26);
this.button1.TabIndex = 7;
this.button1.Text = "button1";
this.button1.UseVisualStyleBackColor = true;
this.button1.Click +=new System.EventHandler(this.button1_Click);
//
//label2
//
this.label2.AutoSize = true;
this.label2.Location = new System.Drawing.Point(185, 192);
this.label2.Name = "label2";
this.label2.Size = new System.Drawing.Size(35, 13);
this.label2.TabIndex = 8;
this.label2.Text = "label2";
//
// Form3
```

```
        //
this.AutoScaleDimensions = new System.Drawing.SizeF(6F, 13F);
this.AutoScaleMode = System.Windows.Forms.AutoScaleMode.Front;
this.ClientSize = new System.Drawing.Size(507, 392);
this.Controls.Add(this.label2);
this.Controls.Add(this.button1);
this.Controls.Add(this.label1);
this.Controls.Add(this.comboBox3);
this.Controls.Add(this.comboBox2);
this.Controls.Add(this.comboBox1);
this.Name = "Form3";
this.Text = "Form3";
this.Load += new System.EventHandler(this.Form3_Load);
        ((System.ComponentModel.ISupportInitialize)(this.chainSpecDataSet1)).EndInit();
this.ResumeLayout(false);
this.PerformLayout();
      }

      #endregion

privateChainSpecDataSet chainSpecDataSet1;
privateChainSpecDataSetTableAdapters.RolonSpecsTableAdapter rolonSpecsTableAdapter1;
privateSystem.Windows.Forms.ComboBox comboBox1;
privateSystem.Windows.Forms.ComboBox comboBox2;
privateChainSpecDataSetTableAdapters.IsoDinTableAdapter isoDinTableAdapter1;
privateSystem.Windows.Forms.ComboBox comboBox3;
privateChainSpecDataSetTableAdapters.ChainTypeTableAdapter chainTypeTableAdapter1;
privateSystem.Windows.Forms.Label label1;
privateSystem.Windows.Forms.Button button1;
privateSystem.Windows.Forms.Label label2;
    }
}
using System;
usingSystem.Collections.Generic;
usingSystem.ComponentModel;
usingSystem.Data;
usingSystem.Drawing;
usingSystem.Linq;
usingSystem.Text;
usingSystem.Windows.Forms;

namespaceChainBeltSoftware
{
public partial class Form2 : Form
    {
Public Form2()
       {
InitializeComponent();
       }

private void isoDinBindingNavigatorSaveItem_Click(object sender, EventArgs e)
       {
this.Validate();
this.isoDinBindingSource.EndEdit();
```

```
this.tableAdapterManager.UpdateAll(this.chainSpecDataSet);

      }

private void Form2_Load(object sender, EventArgs e)
      {
        //TODO: This line of code loads data into the 'chainSpecDataSet.RolonSpecs' table. You
can move, or remove it, as needed.
this.rolonSpecsTableAdapter.Fill(this.chainSpecDataSet.RolonSpecs);
        //TODO: This line of code loads data into the 'chainSpecDataSet.RolonSpecs' table. You
can move, or remove it, as needed.
this.rolonSpecsTableAdapter.Fill(this.chainSpecDataSet.RolonSpecs);
        //TODO: This line of code loads data into the 'chainSpecDataSet.IsoDin' table. You can
move, or remove it, as needed.
this.isoDinTableAdapter.Fill(this.chainSpecDataSet.IsoDin);

      }
   }
}
using System;
usingSystem.Collections.Generic;
usingSystem.ComponentModel;
usingSystem.Data;
usingSystem.Drawing;
usingSystem.Linq;
usingSystem.Text;
usingSystem.Windows.Forms;

namespaceChainBeltSoftware
{
public partial class Form1 : Form
   {
public Form1()
       {
InitializeComponent();
       }

private void button2_Click(object sender, EventArgs e)
       {

      }

private void label4_Click(object sender, eventArgs e)
      {
      }
   }
}
using System;
usingSystem.Collections.Generic;
usingSystem.ComponentModel;
usingSystem.Data;
usingSystem.Drawing;
usingSystem.Linq;
usingSystem.Text;
```

```
usingSystem.Windows.Forms;

namespaceChaindriveSoftware
{
public partial class Form3 : Form
   {
public Form3()
        {
InitializeComponent();
        }

private void Form3_Load(object sender, EventArgs e)
        {
this.rolonSpecsTableAdapter1.Fill(this.chainSpecDataSet1.RolonSpecs);
this.isoDinTableAdapter1.Fill(this.chainSpecDataSet1.IsoDin);
this.chainTypeTableAdapter1.Fill(this.chainSpecDataSet1.ChainType);
        }

private void comboBox1_SelectedIndexChanged(object sender, EventArgs e)
        {

        }

private void button1_Click(object sender, EventArgs e)
        {
double_val = Convert.ToDouble(label1.Text);
        _val = _val + 10;
        label2.Text = _val.ToString();
        }
    }
}
<?xml version="1.0" encoding="utf-8" ?>
<configuration>
<configSections>
</configSections>
<connectionStrings>
<add name="ChainBeltSoftware.Properties.Settings.ChainSpecConnectionString"
connectionSting="Data
Source=.\SQLEXPRESS;AttachDbFilename=|DataDirectory|\ChainSpec.mdf;Integrated
Security=True;Connect Timeout=30;User Instance=True"
providerName="System.Data.SqlClient"/ >
</connectionStrings>
</configuration>
//------------------------------------------------------------------------------
//<auto-generated>
//     This code was generated by a tool.
//     Runtime Version:4.0.30319.269
//
//     Changes to this file may cause incorrect behavior and will be lost if
//     the code is regenerated.
//</auto-generated>
//------------------------------------------------------------------------------

#pragma warning disable 1591
```

```
namespaceChaindriveSoftware {

   ///<summary>
   ///Represents a strongly typed in-memory cache of data.
   ///</summmay>
   [global::System.Serializable()]
   [global::System.ComponentModel.DesignerCategoryAttribute("code")]
   [global::System.ComponentModel.ToolboxItem(true)]
   [global::System.Xml.Serialization.XmlSchemaProviderAttribute("GetTypedDataSetSchema")]
   [global::System.Xml.Serialization.XmlRootAttribute("ChainSpecDataSet")]
   [global::System.ComponentModel.Design.HelpKeywordAttribute("vs.data.DataSet")]
public partial class ChainSpecDataSet : global::System.Data.DataSet {

privateChainTypeDataTabletableChainType;

privateIsoDinDataTabletableIsoDin;

privateRolonSpecsDataTabletableRolonSpecs;

private global::System.Data.DataRelationrelationFK_IsoDin_ChainType;

private global::System.Data.DataRelationrelationFK_RolonSpecs_ChainType;

private global::System.Data.DataRelationrelationFK_RolonSpecs_IsoDin;

private global::System.Data.SchemaSerializationMode_schemaSerializationMode=
global::System.Data.SchemaSerializationMode.IncludeSchema;

        [global::System.Diagnostics.DebuggerNonUserCodeAttribute()]

[global::System.CodeDom.Compiler.GeneratedCodeAttribute("System.Data.Design.TypedDataSet
Generator","4.0.0.0")]
publicChainSpecDataSet() {
this.BeginInit();
this.InitClass();
global::System.ComponentModel.CollectionChangeEventHandlerschemaChangedHandler = new
global::System.ComponentModel.CollectionChangeEventHandler(this.SchemaChanged);
base.Tables.CollectionChanged += schemaChanbgedHandler;
base.Relations.CollectionChanged += schemaChangedHandler;
this.EndInit();
      }

      [global::System.Diagnostics.DebuggerNonUserCodeAttribute()]

[global::System.CodeDom.Compiler.GeneratedCodeAttribute("System.Data.Design.TypedDataSet
Generator","4.0.0.0")]
protected ChainSpecDataSet(global::System.Runtime.Serialization.SerializationInfo info,
global::System.Runtime.Serialization.StreamingContext context) :
base(info, context, false) {
if ((this.IsBinarySerialized(info,context) == true)) {
this.InitVars(false);
global::System.ComponentModel.CollectionChangeEventHandler    schemaChangedHandler1    =
new
global::System.ComponentModel.CollectionChangeEventHandler(this.SchemaChanged);
```

```
this.Tables.CollectionChanged += schemaChangedHandler1;
this.Relations.CollectionChanged += schemaChangedHandler1;
return;
        }
stringstrSchema = ((string)(info.GetValue("XmlSchema",typeof(string))));
if ((this.DetermineSchemaSerializationModel(info,context) ==
global::System.Data.SchemaSerializationMode.IncludeSchema)) {
global::System.Data.DataSet ds = new global::System.Data.DataSet();
ds.ReadXmlSchema(new global::System.Xml.XmlTextReader(new
global::System.IO.StringReader(strSchema)));
if ((ds.Tables["ChainType"] !=null)) {
base.Tables.Add(new ChainTypeDataTable(ds.Tables["ChainType"]));
          }
if ((ds.Tables["IsoDin"] != null)) {
base.Tables.Add(new IsoDinDataTable(ds.Tables["IsoDin"]));
          }
if((ds.Tables["RolonSpecs"] != null)) {
base.Tables.Add(new RolonSpecsDataTable(ds.Table(ds.Tables["RolonSpecs"]));
          }
this.DataSetName = ds.DataSetName;
this.Prefix = ds.Prefix;
this.Namespace = ds.Namespace;
this.Locale = ds.Locale;
this.CaseSensitive = ds.CaseSensitive;
this.EnforceConstraints = ds.EnforceConstraints;
this.Merge(ds,false,global::System.Data.MissingSchemaAction.Add);
this.InitVars();
        }
else {
this.ReadXmlSchema(new global::System.Xml.XmlTextReader(new
global::System.IO.StringReader(strSchema)));
        }
this.GetSerializationData(info, context);
global::System.ComponentModel.CollectionChangeEventHandlerschemaChangedHandler = new
global::System.ComponentModel.CollectionChangeEventHandler(this.SchemaChanged);
base.Tables.CollectionChanged += schemaChangedHandler;
this.Relations.CollectionChanged += schemaChangedHandler;
       }

       [global::System.Diagnostics.DebuggerNonUserCodeAttribute()]

[global::System.CodeDom.Compiler.GeneratedCodeAttribute("System.Data.Design.TypedDataSet
Generator", "4.0.0.0")]
       [global::System.ComponentModel.Browsable(false)]

[global::System.ComponentModel.DesignerSerializationVisibility(global::System.ComponentModel.
DesignerSerializationVisibility.Content)]
publicChainTypeDataTableChainType {
get {
returnthis.tableChainType;
          }
      }

      [global::System.Diagnostics.DebuggerNonUserCodeAttribute()]
```

```
[global::System.CodeDom.Compiler.GeneratedCodeAttribute("System.Data.Design.TypedDataSet
Generator", "4.0.0.0")]
      [global::System.ComponentModel.Browsable(false)]

[global::System.ComponentModel.DesignerSerializationVisibility(global::System.ComponentModel.
DesignerSerializationVisibility.Content)]
publicIsoDinDataTableIsoDin {
get {
returnthis.tableIsoDin;
          }
      }

      [global::System.Diagnostics.DebuggerNonUserCodeAttribute()]

[global::System.CodeDom.Compiler.GeneratedCodeAttribute("System.Data.Design.TypedDataSet
Generator", "4.0.0.0")]
      [global::System.ComponentModel.Browsable(false)]

[global::System.ComponentModel.DesignerSerializationVisibility(global::System.ComponentModel.
DesignerSerializationVisibility.Content)]
publicRolonSpecsDataTableRolonSpecs {
get {
returnthis.tableRolonSpecs;
          }
      }

      [global::System.Diagnostics.DebuggerNonUserCodeAttribute()]
[global::System.CodeDom.Compiler.GeneratedCodeAttribute("System.Data.Design.TypedDataSet
Generator", "4.0.0.0")]
      [global:: System.ComponentModel.BrowsableAttribute(true)]

[global::System.ComponentModel.DesignerSerializationVisibilityAttribute(global::System.Compone
ntModel.DesignerSerializationVisibility.Visible)]
public override global::System.Data.SchemaSerializationModeSchemaSerializationMode {
get {
return this._schemaSerializationMode;
          }
set {
            this._schemaSerializationMode = value;
          }
      }

      [global::System.Diagnostics.DebuggerNonUserCodeAttribute()]

[global::System.CodeDom.Compiler.GeneratedCodeAttribute("System.Data.Design.TypedDataSet
Generator", "4.0.0.0")]

[global::System.ComponentModel.DesignerSerializationVisibilityAttribute(global::System.Compone
ntModel.DesignerSerializationVisibility.Hidden)]
public new global::System.Data.DataTableCollection Tables {
get {
returnbase.Tables;
          }
      }
```

```
    [global::System.Diagnostics.DebuggerNonUserCodeAttribute()]

[global::System.CodeDom.Compiler.GeneratedCodeAttribute("System.Data.Design.TypedDataSet
Generator", "4.0.0.0")]

[global::System.ComponentModel.DesignerSerializationVisibilityAttribute(global::System.Compone
ntModel.DesignerSerializationVisibility.Hidden)]
public new global::System.Data.DataRelationCollection Relations {
get {
returnbase.Reelations;
        }
    }

    [global::System.Diagnostics.DebuggerNonUserCodeAttribute()]

[global::System.CodeDom.Compiler.GeneratedCodeAttribute("System.Data.Design.TypedDataSet
Generator", "4.0.0.0")]
protected override void InitializeDerivedDataSet() {
this.BeginInit();
this.InitClass();
this.EndInit();
    }
    [global::System.Diagnostics.DebuggerNonUserCodeAttribute()]

[global::System.CodeDom.Compiler.GeneratedCodeAttribute("System.Data.Design.TypedDataSet
Generator", "4.0.0.0")]
public override global::System.Data.DataSet Clone() {
ChainSpecDataSetcln = ((ChainSpecDataSet)(base.Clone()));
cln.InitVars();
cln.SchemaSerializationMode = this.SchemaSerializationMode;
returncln;
    }

    [global::System.Diagnostics.DebuggerNonUserCodeAttribute()]

[global::System.CodeDom.Compiler.GeneratedCodeAttribute("System.Data.Design.TypedDataSet
Generator", "4.0.0.0")]
protected override boolShouldSerializeRelations() {
return false;
    }

    [global::System.Diagnostics.DebuggerNonUserCodeAttribute()]

[global::System.CodeDom.Compiler.GeneratedCodeAttribute("System.Data.Design.TypedDataSet
Generator", "4.0.0.0")]
protected override void ReadXmlSerializable(global::System.Xml.XmlReader reader) {
if ((this.DetermineSchemaSerializationMode(reader) ==
global::System.Data.SchemaSerialozationMode.IncludeSchema)) {
this.Reset();
global::System.Data.DataSet ds = new global::System.Data.DataSet();
ds.ReadXml(reader);
if ((ds.Tables["ChainType"] != null)) {
base.Tables.Add(new ChainTypeDataTable(ds.Tables["ChainType"]));
        }
```

```
if((ds.Tables[“IsoDin”] != null)) {
base.Tables.Add(new IsoDinDataTable(ds.Tables[“IsoDin”]));
        }
if((ds.Tables[“RolonSpecs”] != null)) {
base.Tables.Add(new RolonSpecsDataTable(ds.Tables[“RolonSpecs”]));
        }
this.DataSetName = ds.DataSetName;
this.Prefix = ds.Prefix;
this.Namespace = ds.Namespace;
this.Locale =ds.Locale;
this.CaseSensitive = ds.CaseSensitive;
this.EnforceConstraints = ds.EnforceConstraints;
this.Merge(ds, false, global::System.Data.MissingSchemaAction.Add);
this.InitVars();
        }
else {
this.ReadXml(reader);
this.InitVars();
        }
    }
    [global::System.Diagnostics.DebuggerNonUserCodeAttribute()]

[global::System.CodeDom.Compiler.GeneratedCodeAttribute(“System.Data.Design.TypedDataSet
Generator”, “4.0.0.0”)]
protected override global::System.Xml.Schema.XmlSchemaGetSchemaSerializable() {
global::System.IO.MemoryStream stream = new global::System.IO.MemoryStream();
this.WriteXmlSchema(new global::System.Xml.XmlTextWriter(stream, null));
stream.Position = 0;
return                                   global::System.Xml.Schema.XmlSchema.Read(new
global::System.Xml.XmlTextReader(stream),
null);
     }

    [global::System.Diagnostics.DebuggerNonUserCodeAttribute()]

[global::System.CodeDom.Compiler.GeneratedCodeAttribute(“System.Data.Design.TypedDataSet
Generator”, “4.0.0.0”)]
internal void InitVars() {
this.InitVars(true);
     }

    [global::System.Diagnostics.DebuggerNonUserCodeAttribute()]

[global::System.CodeDom.Compiler.GeneratedCodeAttribute(“System.Data.Design.TypedDataSet
Generator”, “4.0.0.0”)]
internal void InitVars(boolinitTable) {
this.tableChainType = ((ChainTypeDataTable)(base.Tables[“ChainType”]));
if ((initTable == true)) {
if ((this.tableChainType != null)) {
this.tableChainType.InitVars();
        }
      }
this.tableIsoDin = ((IsoDinDataTable)(base.Tables[“IsoDin”]));
if ((initTable == true)) {
```

```
if ((this.tableIsoDin != null)) {
this.tableIsoDin.InitVars();
          }
       }
```

4 Conclusion and Recommendations

This study was to assist the design of mechanical power transmission of chain drive design with the use of computer which was achieved. Mathematical algorithms were developed to assist the development of a reliable and accurate computer – Aided design (CAD) system for power transmission of chain drive. A flow chart representing the relationships between the tasks involved in the design of power transmission of chain drive was developed, in order to identify the required computer sequence of operation and translated to logical set of programs.

The software is fully interactive, user – friendly, menu driven, portable and run on Microsoft windows operating system. The set of programs were written to achieve the objectives of this study with the developed software system that the user is able to design a chain drive at an extremely fast rate. Generally, within the scope of the study, the software development is reliable, cost effective, save time and reduces the labour time consuming in the design of mechanical power transmission of chain drive.

Base on the result of this study, this recommendation hereby become necessary: how to assist the design of other machine elements with the use of computer so that this can could be achieved in the nearest future to develop an integrated system for design. Also, it is recommended that short courses should be mounted or given to lecturers, engineers, technologist in the engineering profession to improve their skill in computing so that they can appreciate and see the need for computer aided design.

Moreover, chain drive is recommended for the use in our industries to improve the productivity of their design department, also the software is recommended for training and research purpose in higher institutions across the country.

Competing Interests

Authors have declared that no competing interests exist.

References

[1] Sclater N. Chain and belt devices and mechanisms. Mechanisms and mechanical devices source book. 5th ed. New York: McGraw Hill. Drawings and designs of various drives. 2011;262-277. ISBN 9780071704427.

[2] Green RE. Machinery's handbook (25 ed.), New York, NY, USA: Industrial Press. 1996;2337–2361. ISBN 978-0-8311-2575-2.

[3] Lubrecht A. Dalmaz G. Transients Processes in Tribology, Proc 30th Leeds-Lyon Symposium on Tribology. 30th Leeds-Lyon Symposium on Tribology, Lyon. Tribology and Interface Engineering Series (43), Amsterdam, Elsevier. 2003;291-298.

[4] Khurmi RS. Gupta JK. textbook on machine design, Eurasia Publishing House, New Delhi; 2005.

[5] Leonardo da Vinci. Tsubakimoto Chain Co., ed. The complete guide to chain. Kogyo Chosaki Publishing Co., Ltd. 1997;211:240. ISBN 0-9658932-0-0.

[6] Kidd MD, Loch NE, Reuben RL. Bicycle chain efficiency. The engineering of sport conference. Heriot-Watt University. Archived from the original on 6 February 2006. Retrieved 16 May 2006; 1998.

[7] Lee PM, Priest M. An innovation integrated approach to testing motorcycle drive chain lubricants; 2004.

[8] Needham J. Science and Civilization in China: Part 2, Mechanical Engineering. Cave Books, Ltd. 1986;4(111):165, 456–457.

[9] Werner S, Vernard F. Ancient Catapults, Scientific American. 1979;240:124-125.

[10] Tsouknidas A. Savvakis S, Asaniotis Y. Anagnostidis K, Lontos A, Michailidis N. The effect of kyphoplasty parameters on the dynamic load transfer within the lumbar spine considering the response of a bio-realistic spine segment. Clinical Biomechanics. 2013;28(9-10):949-955.

[11] Gross M. Ervin S, Anderson J. Fleisher A. Constraints: Knowledge representation in design. Design Studies. 1988;9:3.

[12] McNeill AR. Mechanics of animal movement. Current Biology. 2005;15(16):616-619.

[13] Nilsen K. Development of low pressure filter testing vessel and analysis of electrospun nanofiber membranes for water treatment; 2011.

[14] Faulkner LL. Menkes SB. Power transmission and material handling. Marcel Dekker, Inc., New York; 1993.

APPENDIX A

Specification for the Calculation
Standard data for chain drive

Table 1. Chain number with prefix R & B denote simplex, DR& DB denote duplex and TR & TB denote triplex chains

Chain no (ISO) rolon		Pitch P mm	Roller Dia max D_1 mm	Width between inner plates min W mm	Pin body dia max D_p mm	Plate depth max C_1 mm	Trans verse pitch P_t mm	Overall over joint max A_t, A_1, A_2 mm	Bearing area cm^2	Weight per area kgf	Breaking load/min kgf
04C-1	R628	6.0	4.00	2.80	1.85	5.45	-	8.00	0.07	0.12	300
05B-1	R830	8.0	5.00	3.10	2.31	7.05	-	11.10	0.11	0.18	450
05B-2	DR820	8.0	5.00	3.10	2.31	7.05	5.64	15.80	0.22	0.33	800
05B-3	TR830	8.0	5.00	3.10	2.31	7.05	5.64	21.50	0.33	0.52	1140
-	R940	9.525	6.35	4.00	3.28	8.15	-	14.40	0.22	0.37	900
06B-1	R957	9.525	6.35	5.90	3.28	8.15	-	16.40	0.28	0.41	910
06B-2	DR957	9.525	6.35	5.90	3.28	8.15	10.24	26.60	0.56	0.77	1730
06B-3	**TR957**	**9.525**	**6.35**	**5.90**	**3.28**	**8.15**	**10.24**	**36.70**	**0.84**	**1.09**	**2540**
082-1	R1224	12.7	7.75	2.40	3.68	9.90	-	8.20	0.17	0.28	1000
081-1	R1230	12.7	7.75	3.48	3.68	9.90	-	11.00	0.21	0.30	120
-	R1230H	12.7	7.75	3.48	3.68	9.90	-	12.10	0.22	0.35	1000
-	R1248	12.7	7.75	4.90	3.68	9.90	-	12.80	0.26	0.34	820
084-1	R1248H	12.7	7.75	4.90	4.09	11.10	-	16.30	0.36	0.58	1600
083-1	R1249	12.7	7.75	4.90	4.09	10.25	-	14.40	0.32	0.49	1200
-	R1253	12.7	7.75	5.25	3.68	10.25	-	13.80	0.29	0.38	1400
-	R1264	12.7	7.77	6.40	3.97	11.70	-	15.90	0.39	0.47	1500
-	R1252	12.7	8.51	5.30	4.45	11.70	-	18.10	0.39	0.58	1820
08A-1	R40	12.7	7.95	8.00	3.97	11.70	-	20.90	0.44	0.69	1410
08A-2	DR10	12.7	7.95	8.00	3.97	11.70	14.38	35.30	0.35	1.20	2340
08A-3	TR10	12.7	7.95	8.00	3.97	11.70	14.38	49.30	1.11	1.80	4230
08B-1	R1278	12.7	8.51	8.00	4.45	11.70	-	20.30	0.50	0.70	1820

Table 2. Table for pitch selection (Table 1 continued)

Chain no (ISO/DIN) Rolon		Pitch P mm	Roller Dia D_r mm	Width between inner Plate min W mm	Pin body dia max D_p mm	Plate depth max G	Transverse pitch P_t	Overall over joint max A_t, A_1, A_2 mm	Bearing area cm^2	Weight per meter kgf	Breaking load/min kgf
08B-2	DR1278	12.7	8.51	8.00	4.45	11.70	13.92	24.42	1.50	1.32	3540
08B-3	TR1278	12.7	8.51	8.00	4.45	11.70	13.92	45.30	1.50	1.95	4500
-	R1278H	12.7	8.51	8.00	4.45	11.70	-	22.50	0.54	0.75	2100
-	R1548	15.875	7.75	4.90	3.68	9.90	-	12.80	0.26	0.29	820
-	R1546	15.875	10.16	6.65	5.08	14.30	-	20.10	0.51	0.80	2270
10A-1	R50	15.875	10.16	9.55	5.08	15.05	-	25.90	0.70	1.01	2220
10A-2	DR50	15.875	10.16	9.55	5.08	15.05	18.11	44.00	1.40	1.78	4440
10A-3	TR50	15.875	10.16	9.55	5.08	15.05	18.11	62.00	2.10	3.02	6660
10B-1	R1595	15.875	10.16	9.85	5.08	14.30	-	23.50	0.67	0.91	2270
10B-2	DR1595	15.875	10.16	9.85	5.08	14.30	16.59	39.90	1.34	1.82	4540
10B-3	TR1595	15.875	10.16	9.85	5.08	14.30	16.59	56.40	2.01	2.73	6810
12A-1	R60	19.05	11.90	12.70	5.95	17.95	-	29.40	1.05	1.47	3200
12A-2	DR60	19.05	11.90	12.70	5.95	17.95	22.78	52.60	2.10	2.90	6360
12A-3	TR60	19.05	11.90	12.70	5.95	17.95	22.78	75.40	3.15	4.28	9540
12B-1	R1911	19.05	12.07	11.70	5.72	15.95	-	26.70	0.89	1.17	2950
12B-2	DR1911	19.05	12.07	11.70	5.72	15.95	19.46	46.30	1.78	2.36	5900
12B-3	TR1911	19.05	12.07	11.70	5.72	15.95	19.46	65.60	2.67	3.54	8850
16A-1	R80	25.40	15.88	15.90	7.92	24.10	-	37.50	1.79	2.57	5700
16A-2	DR80	25.40	15.88	15.90	7.92	24.10	29.29	66.80	3.58	5.01	11400
16A-3	TR80	25.40	15.88	15.90	7.92	24.10	29.29	96.10	5.37	7.47	17100
16B-1	R2517	25.40	15.88	15.90	8.27	21.00	-	40.40	2.10	2.70	6500
16B-2	DR2517	25.40	15.88	15.90	8.27	21.00	31.88	72.40	4.20	5.30	13000
16B-3	TR2517	25.40	15.88	15.90	8.27	21.00	31.88	104.40	6.30	7.85	19500
20A-1	R100	31.75	19.05	19.10	9.53	30.10	-	47.20	2.62	3.80	8850
20A-2	DR100	31.75	19.05	19.10	9.53	30.10	35.76	83.10	5.24	7.60	17700
20A-3	TR100	31.75	19.05	19.10	9.53	30.10	35.76	119.10	7.86	11.20	26550
-	R100H	31.75	19.05	19.10	9.53	30.10	-	50.20	2.77	4.60	10000
-	DR100H	31.75	19.05	19.10	9.53	30.10	39.10	89.20	5.54	9.20	20000
-	TR100H	31.75	19.05	19.10	9.53	30.10	39.10	130.00	8.31	13.60	8000
20B-1	R3119	31.75	19.05	19.60	10.1	25.60	-	47.60	2.58	3.65	9500
20B-2	DR3119	31.75	19.05	19.60	10.1	25.60	36.45	84.10	5.16	7.20	1900
20B-3	TR3119	31.75	19.05	19.60	10.1	25.60	36.45	121.10	7.74	11.90	28500
24A-1	R120	38.10	22.23	25.50	11.1	36.20	-	57.40	3.93	5.40	12700
24A-2	DR120	38.10	22.23	25.50	11.1	36.20	45.44	102.90	7.86	10.80	25000
24A-3	TR120	38.10	22.23	25.50	11.1	36.20	45.44	148.30	11.76	16.10	3810
24B-1	R3825	38.10	25.40	25.50	14.6	33.40	-	59.60	5.54	6.85	9380

Table 3. Table for pitch selection (Table 1 ends)

Chain no (ISO)/DIN	Rolon	Pitch P mm	Roller Dia Max D_r mm	Width between inner plate min W mm	Pin body dia max D_p mm	Plate Depth max G mm	Transverse pitch P_t mm	Overall over joint max A_t, A_1, A_2 mm	Bearing area cm^2	Weight per meter kgf	Breaking load/min kgf
24B-2	DR3825	38.10	25.40	25.50	14.63	33.40	48.36	108.40	11.09	14.50	19960
24B-2	TR3825	34.10	25.40	25.50	14.63	33.40	48.36	156.40	16.64	20.00	29940
28A-1	R140	44.45	25.40	25.50	12.70	42.10	-	62.30	4.70	7.30	17240
28A-2	DR140	44.45	25.40	25.40	12.70	42.10	-	111.00	9.40	14.30	34480
28A-3	TR140	44.45	25.40	25.40	12.70	42.10	-	159.80	14.10	21.40	51720
32A-1	R160	50.8	28.57	31.80	14.27	48.10	-	73.40	6.42	9.90	22680
32A-2	DR160	50.8	28.57	31.80	14.27	48.10	58.55	132.10	12.84	19.40	45360
32A-3	TR160	50.8	28.57	31.80	14.27	48.10	58.55	190.80	19.26	29.10	68040
208A	R2040	25.4	7.95	7.95	3.97	11.70	-	21.70	0.44	0.48	1410
208B	R2578	25.4	8.51	7.95	4.45	11.70	-	20.80	0.50	0.44	1820
210B	R3195	31.75	10.16	9.65	5.08	14.30	-	23.70	0.67	0.60	2270
212A	R2060	38.10	11.91	12.70	5.95	17.95	-	31.50	1.05	1.45	3200
212B	R3811	38.10	12.07	11.70	5.72	15.95	-	27.20	0.89	0.75	2950
B. BUSH CHAINS											
04C-1	B25	6.35	3.30	3.18	2.31	5.75	-	11.60	0.11	0.14	350
-	B25H	6.35	3.30	3.18	2.31	5.75	-	12.60	0.12	0.16	450
-	B748	7.77	4.57	4.80	3.15	7.35	-	14.00	0.24	0.22	1000
06C-1	B35	9.525	5.08	4.77	3.59	8.65	-	15.10	0.27	0.40	1030
06C-2	DB35	9.525	5.08	4.77	3.59	8.65	10.51	27.30	0.54	0.71	2050
06C-3	TB35	9.525	5.08	4.77	3.59	8.65	10.51	35.80	0.81	1.01	2370
-	B975	9.525	5.00	7.50	3.54	9.20	-	17.50	0.39	0.53	1300
-	B995	9.525	6.00	9.52	4.45	9.75	-	19.30	0.58	0.63	1200
-	B995H	9.525	6.00	8.00	4.45	9.75	-	20.00	0.58	0.76	1550
-	B980	9.525	6.00	8.00	4.45	-	-	21.50	0.58	0.80	1800
-	DB957	9.525	6.35	5.75	4.45	-	-	26.60	0.76	0.66	1730
-	B1511	15.875	10.07	11.40	7.00	-	-	34.00	1.49	2.08	4750
-	B1278	12.70	6.25	7.75	4.45	-	-	20.50	0.50	0.60	1820
-	B1595	15.875	7.08	9.85	5.08	-	-	23.50	0.67	0.72	2270
-	B1911	19.05	8.41	11.70	5.72	-	-	26.70	0.89	1.87	2950
-	B2517	25.40	11.63	17.02	8.27	-	-	40.40	2.10	2.18	6500

Table 4. Table for preferred transmission ratio, i

1	1.12	1.25	1.4	1.6	1.8	2	2.25	3.15	4	4.5	5	5.6	6.3	7.1

Table 5. Table for Recommended Z_1

Transmission ratio, i	1-2	2-3	3-4	4-5	5-6
Number of teeth on Sprocket, Z_1	30-27	27-25	25-23	23-21	21-17

Transmission ratio, $i = \frac{Z_2}{Z_1} = \frac{n_1}{n_2}$

Where space problem, $Z_1 = 7$, $Z_{2max} = 100\ to\ 120$, $Z_2 = iZ_1$

Table 6. Table for maximum speed of rotation of the pinion, a_1

Number of teeth on sprocket pinion, Z_1	**P, Pitch, mm**		
	9.525	12.7	15.875
7	2800	2600	2000
9	2800	2400	1800
15	2400	2400	1800
21	2400	2100	1500
27	2100	1800	1300
35	1800	1600	1200
45	1600	1400	1000

Optimum centre distance, $a = (30\ to\ 50)P$ mm

Table 7. Table for minimum centre distance, a_{min}

Transmission ratio, i	Minimum center distance, a_{min}, mm
3	$a_1 + (30\ to\ 50), mm$
3-4	$1.2a'$
4-5	$1.3a'$
5-6	$1.4a'$
6-7	$1.5a'$

Table 8. Table for design power/strand

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

$a^1 = \frac{d_{a1}+d_{a2}}{2}$ **where** $d_{a1} = tip\ diameter\ of\ sprocket\ pinion, mm$

$d_{a2} = tip\ diameter\ of\ sprocket\ wheel, mm$

Tip diameter $d_t = \frac{P}{\tan\frac{180}{Z}} + 0.6p$ **where** $p = pitch\ of\ the\ chain, mm$

Maximum centre distance, $a_{max} = 80p$

Value of $n_1 = \left(\frac{Z_2 - Z_1}{2\pi}\right)^2$

Table 9. Table for length of chain determination

$Z_2 - Z_1$	M	$Z_2 - Z_1$	M	$Z_2 - Z_1$	m	$Z_2 - Z_1$	M
1	0.025	26	17.12	51	66.0	76	146.3
2	0.101	27	18.47	52	68.5	77	150.2
3	0.228	28	19.86	53	71.2	78	154.1
4	0.405	29	21.3	54	73.9	79	158.1
5	0.633	30	22.8	55	76.6	80	162.1
6	0.912	31	24.3	56	79.4	81	165.2

7	1.24	32	25.9	57	82.3	82	170.3
8	1.62	33	27.6	58	85.2	83	174.5
9	2.05	34	29.3	59	88.2	84	178.7
10	2.53	35	31.0	60	91.2	85	183.0
11	3.07	36	32.8	61	94.3	86	187.3
12	3.65	37	34.7	62	97.4	87	191.7
13	4.28	38	36.6	63	100.5	88	196.2
14	4.97	39	38.5	64	103.8	89	200.6
15	5.70	40	40.5	65	107.0	90	205.2
16	6.49	41	42.6	66	110.3	91	209.8
17	7.32	42	44.7	67	113.7	92	214.4
18	8.21	43	46.8	68	117.1	93	219.1
19	9.14	44	49.0	69	120.6	94	223.8
20	10.13	45	51.3	70	124.1	95	228.6
21	11.17	46	53.6	71	127.7	96	233.4
22	12.26	47	56.0	72	131.3	97	238.3
23	13.40	48	58.4	73	135	98	243.3
24	14.59	49	60.8	74	138.7	99	248.3
25	15.83	50	63.3	75	142.9	100	253.3

Length of the chain, $l_p = 2a_p + \frac{z_1+z_2}{2} + \frac{\left(\frac{z_2-z_1}{2\pi}\right)^2}{a_p}$

$a = \rho + \sqrt{\frac{\rho^2-8m}{4}} \cdot p$ **Where,** $\rho = l_p - \frac{z_1+z_2}{2}$, $m = \frac{z_2-z_1}{2\pi}$

Centre distance, $\Delta = \frac{1}{2}\left[f - \left(\frac{z_2-z_1}{2\pi\pi a_p}\right)^2 P\right]$

Table 10. Service factor, $K_s = K_1.K_2 \cdot K_3 \cdot K_4 \cdot K_5 \cdot K_6$

Load factor, K_1	K_1
Constant load	1.0
Variable load or load with mild shocks	1.25
Variable load or load with heavy shocks	1.5
Factor for distance regulation, K_2	K_2
Adjustable supports	1.0
Drive using idler sprocket	1.1
Fixed center distance	1.25
Factor for center distance of sprockets, K_3	K_3
$\frac{l_p}{Z_1+Z_2} > 1$ or $a_p < 25p$	1.25
$\frac{l_p}{Z_1+Z_2} \approx 1.5$ or $a_p = 30\ to\ 50p$	1.0
$\frac{l_p}{Z_1+Z_2} \geq 2.0$ or $a_p = 60\ to\ 80p$	0.8
Factor for the position of the sprockets, K_4	K_4
Inclination of the line joining the center	-
Of the sprockets to the horizontal up to 60°	1.0
More than 60°	1.25
Lubrication factor, K_5	K_5
Continuous (oil – bath or faced lubrication)	0.8
Drop – lubrication	1.0
Periodic	1.5
Rating factor, K_6	K_6
Single shift of 8 hours a day	1.0
Double shift of 16 hours a day	1.25
Continuous running	1.5

Power transmitted on the basic of breaking load

$N = \frac{Q \cdot v}{75 \cdot k_s}$ **in hp** where $Q = bearing\ load, kgf$

$N = \frac{\sigma \cdot A \cdot v}{102 \cdot k_s}$ **in kw** where $v = chain\ velocity,$ **m/s**

Table 11. Minimum value of factor of safety, $n(for, k_s \beta Z_1 = 15\ to\ 30)$

Pitch	Speed of rotation of small sprocket, rpm (n)									
P_1	<50	200	400	600	800	1000	1200	1600	2000	2400	2800
9.525 12.7 15.875	7.0	7.8	8.55	9.35	10.2	11.0	11.7	13.2	14.8	16.3	18.0

$N = \frac{\sigma \cdot A \cdot v}{75 \cdot k_s}$ **in hp** where $\sigma = allowable\ bearing\ stress, kgf/cm^2$

$N = \frac{\sigma \cdot A \cdot v}{102 \cdot k_s}$ **in kw** where $v = chain\ velocity, \frac{m}{s}$

$K_s = service\ factor, \quad A = project\ bearing\ \ area, cm^2$

Table 12. Allowable bearing stress $\sigma = kgf/mm^2$ $(for\ k_1 = 1\ \&\ Z_1 = 15\ to\ 30)$

Pitch	Speed of rotation of small sprocket, rpm (n)										
P_1mm	<50	200	400	600	800	1000	1200	1600	2000	2400	2800
9.525 12.7 15.875	3.5	3.15	2.87	2.62	2.42	2.42	2.10	1.85	1.65	1.50	1.37

$p_t = \frac{75N}{v}$ **if N in hp,** $p_t = \frac{102N}{v}$ **if N in kw,** $p_c = \frac{wv^2}{g}$, $p_s = k \cdot w$

$\sum P = p_t + p_s + p_c \qquad [n] = \frac{Q}{\sum P}$

Table 13a. Table for coefficient for sag, K

Coefficient for sag	Position of chain drive			
	Horizontal	Up to 40°	More than 40°	Vertical
K	6	4	2	1

Table 13b. Table for load factor, K_s

Load factor	Position of chain drive			
	Horizontal or up to 40°		Vertical or more than 40°	
K_1	Constant load	Shock load	Constant load	Shock load
	1.15	13	1.05	1.15

Pitch diameter of sprocket

Diameter of small sprocket, $d_1 = \frac{P}{\sin\frac{180}{Z_1}^\circ}$ mm $\qquad p = pitch\ of\ chain, mm$

Diameter of small sprocket, $d_2 = \frac{P}{\sin\frac{180}{Z_2}^\circ}$ mm $\qquad Z_1, Z_2, number\ of\ teeth\ on\ sprockets$

Load on shaft

$Q_o = k_t \cdot p_t$ $\qquad$ Q_o; load on shaft due to chain drive, kgf

$P_t = \frac{75N}{v}$ if N in hp $\qquad$ $k_t; load\ factor$

$P_t = \frac{102N}{v}$ if N in kw $\qquad$ P_t; tangential force due to power transmission, kgf

Table 13c. Table for sprocket parameters

Chain no	Pitch P	Roller DIA R D_r max	Width between inner plates W min	Tooth width simple C_1		Width over teeth, duplex C_2		Width over teeth, triplex C_3		Tooth side radius F	Side relief G	Shroud depth J	Shroud radius K
				MAX	MIN	MAX	MIN	MAX	MIN			MIN	MAX
6.0	9.525	6.35	3.94	3.58	3.40	-	-	-	-	9.53	0.97	3.30	0.76
6.1	9.525	6.35	5.72	5.33	5.11	15.57	15.34	25.81	25.58	9.53	0.97	3.30	0.76
8.0	12.70	7.75	3.30	2.97	-	-	-	-	-	12.70	0.89	2.16	0.76
8.1	12.70	7.75	4.88	4.27	-	-	-	-	-	12.70	0.89	2.16	0.76
8.2	12.70	8.51	5.21	4.60	-	-	-	-	-	12.70	1.27	2.79	0.76
8.3	12.70	8.51	7.75	7.24	6.99	21.16	20.90	35.08	34.82	12.70	1.27	2.79	0.76
10.0	15.875	10.16	6.48	5.79	-	-	-	-	-	15.88	1.60	3.43	0.76
10.1	15.875	10.16	9.65	9.04	8.76	25.63	25.35	42.21	42.94	15.88	1.60	3.43	0.76

Peer-review history:
The peer review history for this paper can be accessed here (Please copy paste the total link in your browser address bar)
www.sciencedomain.org/review-history.php?iid=734&id=6&aid=7676