

PARAMETRIC MODELING AND DRAWING AUTOMATION FOR FLANGE COUPLING USING EXCEL SPREADSHEET

DHAVAL B. SHAH

Assistant Professor, Institute of Technology, Nirma University, Ahmedabad, Gujarat, India

ABSTRACT

Coupling is a mechanical device which used widely in many big and small scale industries. 3D solid modeling has been mostly used since last few years as a substitution and complementation of the conventional 2D drafting. However, in general, many draftsmen do not have the skills of performing such 3D modeling as well as it takes lots of time. One way of overcoming this problem is to develop a tool which can perform 3D modeling as well as 2D drafting automatically. In this paper an attempt has been made to integrate commercially available package Autodesk Inventor with Microsoft Excel spreadsheet for creation of modeling and manufacturing drawing. Various product variants of the flange coupling have been executed by parametric designing concept in Inventor. It is easy for the user to give necessary input data in an Excel spreadsheet. Then using one feature crates in Inventor software the 3D modeling and manufacturing drawings will be generated automatically and efficiently.

KEYWORDS: Parametric Modeling, Computer Aided Design, Modeling and Drawing Automation, Flange Coupling

INTRODUCTION

Coupling is a mechanical component used to connect two shafts together at their ends for the purpose of transmitting power. The rigid flange coupling is specially designed and developed for horizontal shaft mounted gear unit applications. These applications require a rigid link between the low speed shaft of the gear unit and the machine, such as for conveyor drive, bucket elevator, travel drive applications etc. In rigid flange coupling, flanges are brought together and are bolted in the annular space between the hub and the protecting flange.

The protective flange is provided to guard the projecting bolt heads and nuts. The bolts are placed equispaced on a bolt circle diameter and the number of bolt depends on the shaft diameter. A spigot on one flange and a recess on the opposing face are provided for ease of assembly. The design procedure is generally based on determining the shaft diameter for a given torque transmission and then empirical relations different dimensions of the coupling are obtained.

Many research efforts have been made in the area of parametric modeling and drawing automation. Zhang et al. [2] demonstrates modeling automation system for electronic package thermal analysis using Excel spreadsheet. Ongkodjojo and Gunawan [3] explained the technique of how to get full control on model by managing and driving the parameters attached to it by customizable flat bed conveyor design. They demonstrated the technique of developing product variants based on a single template model.

Trivedi et al. [4] described the technique of 3D parametric modeling for product variants using case study on inner ring of spherical roller bearing. They explored the method for integration of Pro/Engineer with Microsoft Excel. Chu et al. [5] developed computer aided parametric design for 3D tire mold production. Thakkar and Patel [6] defined the technique for interfacing through MS Excel and C language by the case study of pulley design.

PROGRAM DEVELOPMENT FOR DESIGN CALCULATION

Dimensions of couplings are changed as per power transmitting capacity is changed. Coupling parts are having similarity in geometry, but different in dimensions. So, every time all the dimensions of coupling parts will be calculated, which is very tedious and time consuming. To minimize time and human power, a program is developed for calculation purpose. The output from the program which is dimensions of different components of coupling is directly linked to solid modeling software to get product drawing. In industries the manufacturing drawing is prepared using AutoCAD as a drafting tool. There was a lot of time consuming in editing, revising the drawing such as a fabrication drawing in AutoCAD. Thus, it is needed to automate the manufacturing drawing of such components.

The design of protected type rigid flange coupling is as per standard design procedure which mainly consists of empirical relations. So, it is very easy to calculate all the dimensions in Microsoft Excel for this mechanical device. A Microsoft Excel spreadsheet has been widely used in many fields because of its widespread availability and ease of use. The dimensions of all components for flange coupling like hub, flange, and rim etc. are calculated using empirical relations which are fed inside the Excel spreadsheet. The inputs for this are only power, speed, material strength and factor of safety, which are shown in yellow color boxes in Figure 1. All remaining parameters are calculated automatically based on mathematical relations. When shaft diameter and bolt diameter are calculated using standard design equations they have fractional values. But, in the market only standard diameter shafts and bolts are available. So, the standard shaft diameter and standard bolt diameter values database are stored in another Excel spreadsheet and they are taken using the VLOOKUP function in the main spreadsheet.

Parameter	Symbol	Value
Power (kilowatt)	P	50
Speed (rpm)	N	400
Yield Strength of material (Mpa)	Syt	400
Factor of Safety for shaft	FOS	4
Shaft Diameter (mm)	d	50
Diameter of hub (mm)	dh	100
PCD of bolts (mm)	D	150
Recess and Spigot Dia (mm)	dr	75
Length of Hub (mm)	lh	75
Length of outer rim (mm)	t2	50
Thickness of Rim (mm)	t1	12.5
Flange Diameter (mm)	Do	225
Diameter of Bolt (mm)	d1	8
No. of Bolts	No	4

Figure 1: Design Calculation Using Excel Spreadsheet

RESEARCH METHODOLOGY

The protected type rigid flange coupling is designed as per standard procedure. In order to reduce cycle time in the creation of drawings for the assembly of the coupling, the automation has been produced by Autodesk Inventor and it is linked with Microsoft Excel software. Initially the Autodesk Inventor software and Excel spreadsheet has been linked using parameters feature. Then all the symbols mentioned in the Excel spreadsheet will appear in parameters window in

parameter name column as shown in Figure 2.

Parameter Name	Unit	Equation	Nominal Value	Tol.	Model Value	Export	Comment
d50	mm	t2	50.000000	-	50.000000	<input type="checkbox"/>	
d51	mm	d50 / 2 ul	25.000000	-	25.000000	<input type="checkbox"/>	
d70	mm	d	50.000000	-	50.000000	<input type="checkbox"/>	
d73	mm	D / 2 ul	75.000000	-	75.000000	<input type="checkbox"/>	
d74	mm	5 mm	5.000000	-	5.000000	<input type="checkbox"/>	
d75	deg	0 deg	0.000000	-	0.000000	<input type="checkbox"/>	
d78	mm	D / 2 ul	75.000000	●	75.000000	<input type="checkbox"/>	
d79	mm	d1	8.000000	●	8.000000	<input type="checkbox"/>	
d86	ul	4 ul	4.000000	●	4.000000	<input type="checkbox"/>	
d87	deg	360 deg	360.000000	●	360.000000	<input type="checkbox"/>	
- Reference Pa...							
d72	mm	100.000 mm	100.000000	●	100.000000	<input type="checkbox"/>	
- User Paramet...							
- D:\10bme022...							
P	mm	50 mm	50.000000	●	50.000000	<input type="checkbox"/>	
speed	mm	400 mm	400.000000	●	400.000000	<input type="checkbox"/>	
Syt	mm	400 mm	400.000000	●	400.000000	<input type="checkbox"/>	
d	mm	50 mm	50.000000	●	50.000000	<input type="checkbox"/>	
d_h	mm	100 mm	100.000000	●	100.000000	<input type="checkbox"/>	
D	mm	150 mm	150.000000	●	150.000000	<input type="checkbox"/>	
dr	mm	75 mm	75.000000	●	75.000000	<input type="checkbox"/>	
lh	mm	75 mm	75.000000	●	75.000000	<input type="checkbox"/>	
t2	mm	50 mm	50.000000	●	50.000000	<input type="checkbox"/>	
t1	mm	12.5 mm	12.500000	●	12.500000	<input type="checkbox"/>	
Do	mm	225 mm	225.000000	●	225.000000	<input type="checkbox"/>	
d1	mm	8 mm	8.000000	●	8.000000	<input type="checkbox"/>	
no	mm	4 mm	4.000000	●	4.000000	<input type="checkbox"/>	

Figure 2: Parameters Window

3D CAD models using different features like revolve, extrude, cut, pattern etc. as per requirement using Autodesk Inventor part module has been created. At the times of giving dimension to any sketch or feature use parameters which are previously linked. The individual models of male and female flanges are shown in Figure 3 and 4.



Figure 3: Male Flange

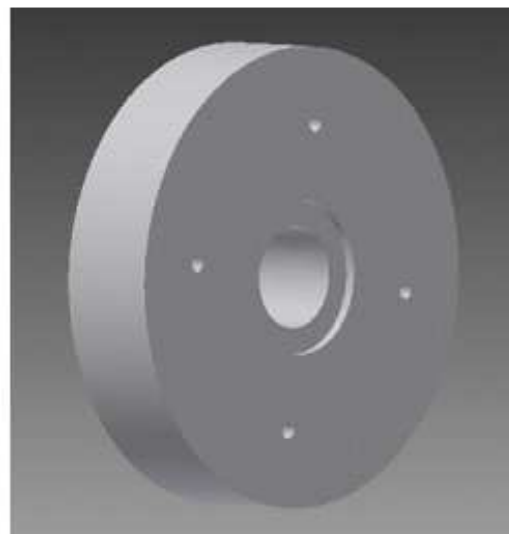


Figure 4: Female Flange

The assembly of rigid flange coupling has been created using an assembly module in Autodesk Inventor by giving different constraint feature. The isometric view of the same is shown in Figure 5.

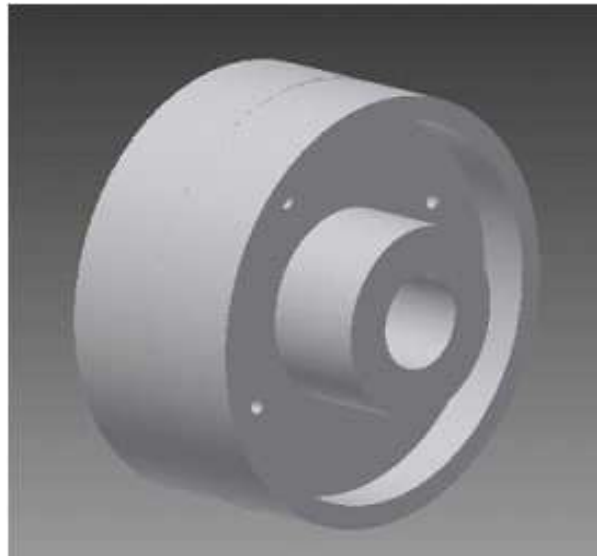


Figure 5: Assembly Model of Coupling

The detail drawing of the assembly has been created using drawing module available in Autodesk Inventor. Different views of assembly like front view, side view, section view and isometric view has been created using different features. The detail drawing having different views is shown in Figure 6. The dimensions of different views have been applied using the dimension feature in drawing module.

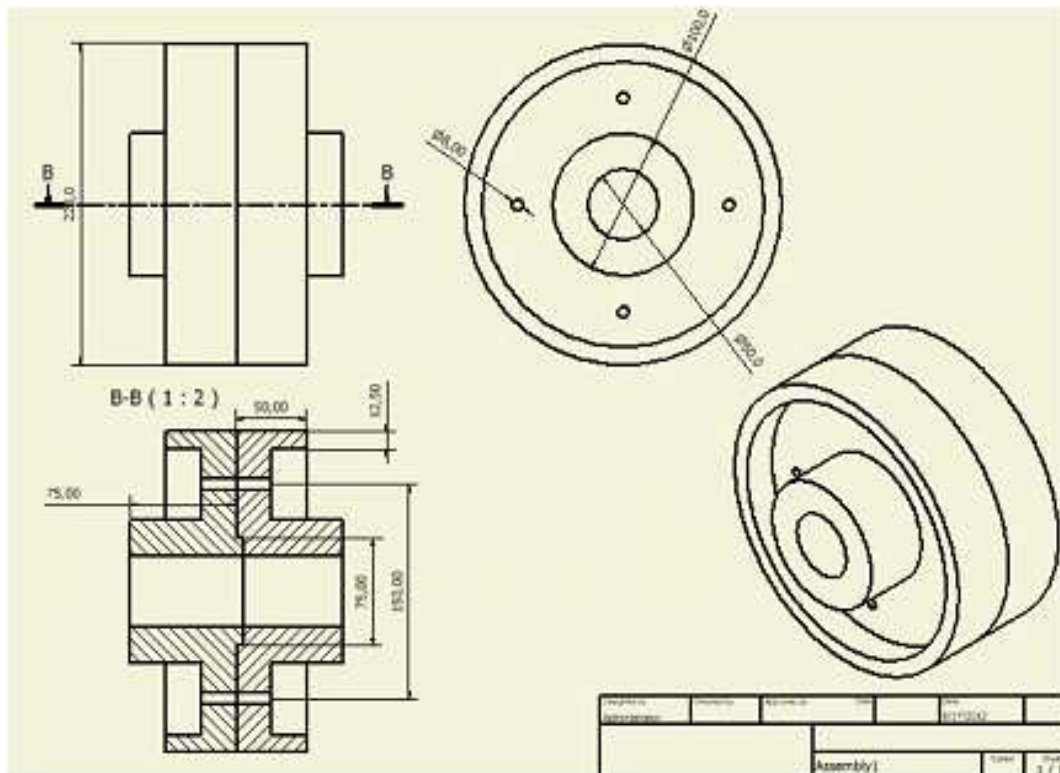


Figure 6: Detail Drawing of Coupling

PROCEDURE FOR MODIFYING THE MODEL

The basic methodology for design automation as per given input data has been given in flow chart as shown in the Figure 7. 3D models and 2D drawing views of flange coupling from input values in Excel spreadsheet have been created by the procedure described in the flow chart.

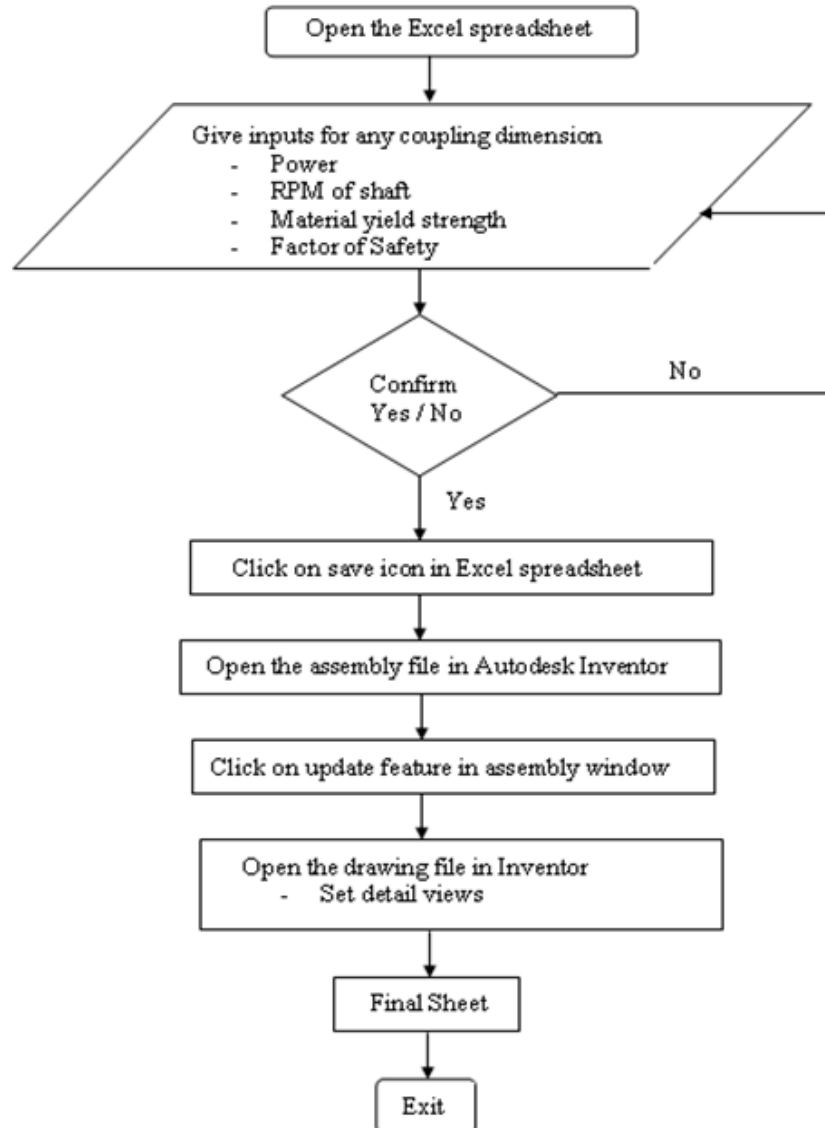


Figure 7: Flowchart to Modify the Model

CONCLUSIONS

3D models for flange type coupling and related dimension database in Microsoft Excel have been prepared. This Excel sheet has been linked with Autodesk Inventor to transfer data and relate to respective features of the part. User can update the model just by modifying the sheet. This takes comparatively very less time to generate complex part models with respect to generating them individually. This modeling and drawing automation technique is more suitable and simpler than any other techniques. This automation can further be proceeded by exporting models to the analysis or CAM package.

REFERENCES

1. Bor-Tsuen Lin, Shih-Hsin Hsu (2008). Automated design system for drawing dies.
2. Y. Zhang, L. Liang, Y. Xia (2007). Modeling automation system for electronic package thermal analysis using Excel spreadsheet.
3. S. Ongkodjojo, H. Gunawan (2006). 3D parametric modeling for product variants with study case on flatbed conveyor.

4. Ruchik Trivedi, Dhaval Shah, Kaushik Patel (2013). 3D Parametric Modeling for Product Variants Using Case Study on Inner Ring of Spherical Roller Bearing.
5. Chih-Hsing Chu, Mu-Chi Song, Vincent C.S. Luo (2006). Computer aided parametric design for 3D tire mold production.
6. Thakkar A. and Patel Y. (2012). Integration of PRO/E with Excel and C language for design automation, India: IJERT, pp. 1-4
7. Bhandari V.B. (2001), Design of machine element, 3rd Edition, McGraw Hill Education, India Pvt. Ltd.
8. Shigley J. E. (1986). Mechanical engineering design, McGraw Hill Education, India Pvt. Ltd.
9. Autodesk Inventor Help
10. Microsoft Excel Help