Middle-East Journal of Scientific Research 20 (10): 1239-1246, 2014
ISSN 1990-9233
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DOI: 10.5829/idosi.mejsr.2014.20.10.114100

Computer Aided Design and Analysis of Power Press

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Abstract: The objective of this study is to investigate the finite element modelling of 'C' frame power press of 10 tonne capacity and to analyse the power press under static condition. Any press is comprised of a frame a bed or bolster plate and a reciprocating member called ram or slide which exerts force upon work material through special tools mounted on the ram and bed. The first stage involves the modelling of the C- frame power press in Pro/E software. The 3D model of the power press is analyzed in static condition to find the stresses and deflections in the structure. The second stage involves the reduction in weight of the power press by varying or reducing the thickness of frame and bed and the press is analysed in static condition to find the results.

Key words: To analyse the power press · Stage involves the modelling · Reduction in weight · Analysed in static

INTRODUCTION

Power Press: Power press are used for producing large quantities of articles quickly, accurately and economically from the cold working of mild steel and other ductile materials. The components produced range over an extremely wide field and are used throughout industry. Sometimes the pressings may be complicated and more than one pressing operation may be required. Now-a-days practice is to produce most of the sheet parts of any shape by using specially designed press tools and other combination of operations. For economical production of quantities of pressings, consideration has to be given to the rate of production, the cost of the press tools to be employed and the expenditure involved in setting them. It is also necessary to plan the operations to reduce scrap material to a minimum and to use waste material for other smaller pressings. For any operations to be performed on press, the selection of the proper press and the design of the tool or die to be mounted on it are very important [1].

Hydraulic Press: Hydraulic Press is a machine in which a large force is exerted on the larger of two pistons in a pair of hydraulically coupled cylinders by means of a relatively small force applied to the smaller piston. They display superior performance through innovative ideas. The hydraulic presses range from 5 Tons to 5000 Tons capacity [2].

Operation Modes: The hydraulic presses have specific operation modes:

1. Fully Automatic 'PLC'-Controlled
2. Contractors/Relay based

Frame Structures: The frame structures of these presses are:

1. 'H' TYPE OR fabricated 4-column type
2. 'C' type
3. 4-pillars (Hard chrome pillars type)

Applications: The hydraulic presses have exclusive applications in the following spheres:

1. Deep drawing operations
2. Blanking and Punching
3. Riveting, Stamping and Pressing
4. Powder Compacting

C frame type presses

1. These presses offer maximum access to tool area for tool changing and component feeding applications.

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2. Range: 5 Tons to 300 Tons capacity.
3. Slides guidance can be either twin pillars type or face slides.
4. Hydraulic power pack is inbuilt and all valves are manifold mounted for easy and quick maintenance and a pressure relief valve protects against overloading of the press. 5. Additional equipments: a. Ejectors in either the slide or under the press bed. b. Die cushioning arrangement for deep drawing.

Press Operations: Press tools may be designed for carrying out the following or more operations:

- Piercing: Removal of a local piece of the material to form a hole of some shape.
- Cutting and shearing.
- Blanking: Production of the contour in flat blank clipping, shearing, etc.
- Curling
- Drawing: Production of deep cup component from flat strip.
- Bending: Material is bent in one place.
- Deep drawing, shallow drawing, redrawing.
- Extrusion.

In addition, the operations of cupping (production of a cup from disc), coining and trimming (truing up the edges of a pressing), coining, interlocking, riveting, forging, impact extrusion may also be carried [3-5].A

Power Press Parts and Accessories: The different parts of a power press illustrated in fig. are described below:

- Base
- Frame
- Bolster plate
- Ram or slide
- Pitman
- Crank shaft or eccentric or other driving mechanism
- Clutch
- Brake
- Knock out
- Cushion.

Description of the Problem: Power presses are used to produce large quantities of articles economically, quickly and accurately. Here a 'C' framed power press is taken into consideration, for punching operation. There are many operations performed in a power press, but in this project we consider punching operation. While punching, the Ram has to travel from the punch holder to the die block. So in this operation, due to the ram speed and force, some deflections are undergone in the structure. Here we are going to consider the deflections and stresses in the structure and minimize the material wherever there is no deflection and stress. Hence this reduces the weight of the power press and minimizes the cost of the production.

Source of the Project: The source of the project is from the company, BHARATH PRESSINGS, Pvt Ltd, Chennai. The dimensions and specifications of a 10 tonne capacity press are obtained from this company. The manufacturer of the C framed power press is BEMCO PRESSES, Pune.

Need of the Project: Standard C-Frame presses bring hydraulic precision and control to most pressroom applications including punching, blanking, coining, forming, bending, drawing and assembly work. The C-frame press is considered because of its high rigid frame construction and also the maintenance cost of the press is less compared to other. In most of the presses there are some waste materials where no stress is acting there. This increases the material weight and cost for the manufacturer. So these materials should be removed to reduce the material usage to increase the profit for the manufacturer.

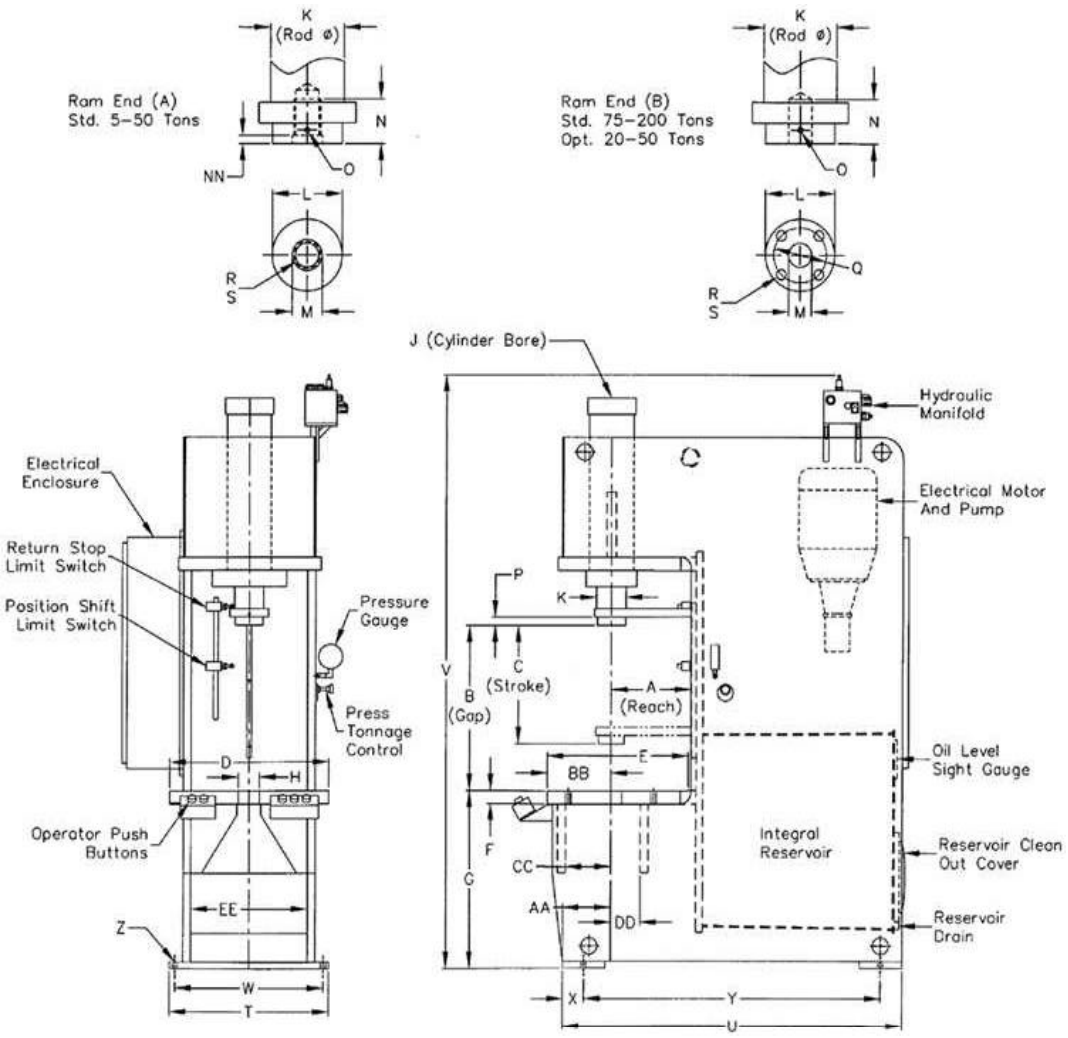
METHODOLOGY

First the dimensions and specifications for a C framed power press is taken from a manufacturer. Using the specifications and dimensions a C framed power press is modelled in pro/E, and then the model is imported to Ansys package for analysis. The static load condition is considered for analysis. As per the specifications the load is applied on the ram and the deflections and stresses acting on the structure are calculated. According to the analysis results, the materials can be removed as the defections are less in certain areas. Then again an analysis is made to the modified press, so that the deflections and stresses underwent by this modified one is same as that of the original model. Finally the stresses and deflections of the presses are compared.

Design Specifications

Frame thickness	-	25mm
Total Height of the press	-	1990mm
Area of the bed	-	600x400mm
Bed thickness	-	100mm
Breadth of the frame	-	1030mm
Floor to top of bed	-	710mm
Diameter of the Ram	-	120mm
Stroke Length	-	300mm

'C' Frame Power Press Views



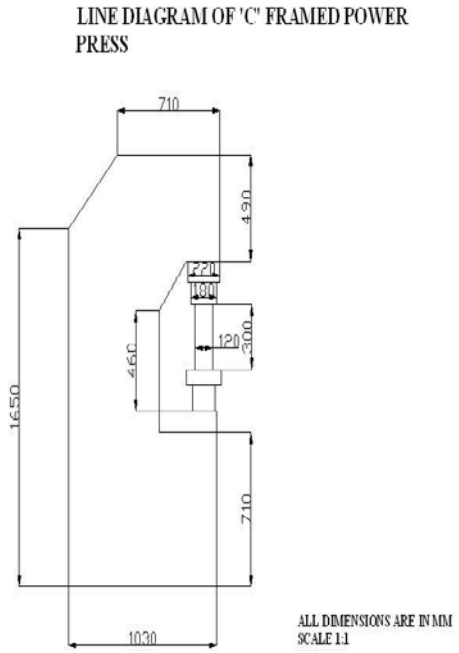
Line Diagram of the Power Press: Steps involved in modelling of power press:

1. Setting the working directory: When the Pro/e session is started, the first task is to set the working directory. A working is a directory on the system where we can save the work done in the current session of Pro/e. we can set any directory existing.

2. Creating a New Object File for the Frame: The solid models are created in the part mode of Pro/Engineer. The extension for the file created in this mode is .prt. The first component is the Frame. The base feature is created by extruding the sketch, drawn according to the specifications and dimensions collected from the company. The extrude tool will be used to create the base feature. After the extrusion is done the cut is used at the section according to the model. Then in the corners Round is made. A hole is made for the Ram location. This gives out the frame modelling for the power press.

3. Saving the model: After the modelling of the base feature the model is to be saved, so that it can be used to retrieve for assembling.

4. Creating Bed: The second component is the Bed for the power press. Here the Extrude option is selected for the modelling. To create the protrusion feature for this component, Top datum plane is selected as a sketching plane. This is because the direction of extrusion is normal to the top datum plane. The dimensions are referred from the table given below. Then the feature is drawn



according to dimensions, and extruded. After the model is generated it is saved as part file.

5. Creating a Bolster plate: The bolster plate is used for the mounting of press tools. It is modelled from the sketcher and Extruded to the dimensions specified below. The holes are made to fix the plate on the bed. Before creating a hole feature, we have to create a datum axis. This axis will act as an axial reference for the hole that will be created on the Bolt Circle Diameter (BCD) of 2mm. then the feature is saved in .prt extension.

6. Creation of Ram: The Ram is modelled by selecting the Revolve feature and then the angle of revolution is 360 degrees. An axis is created in the sketcher window so that the feature we draw in will rotate according to this axis of revolution.

Steps Involved in Assembling of the Power Press: After the modelling is done we have to assemble all the components of the fixture assembly. As mentioned earlier an assembly is defined as a design consisting of two or more than components in which we can apply some specific assembly constraints to the parts so that their Degree of Freedom (DOF) is controlled or restricted. Various assembly constraints, such as Mate, Align, Insert, and Orient and so on are used to control the DOF between the components.

The various steps involved in the assembling of power press are:

1. Creating a New Assembly File: To start with an assembly we have to create a new assembly file. Then first base feature, Frame is inserted by selecting Add Component in the Right Tool chest. Then Default Constraint is selected to place the Frame model in the default coordinate system of the assembly.

2. Assembling the Bed: The second component in the Power press assembly is the bed. Choosing the Add Component button the Bed.prt part model is inserted. Then proper constraints are made to fix the bed. Mate, Align of the surface and axis are used to constraint the bed until fully constrained message appears.

3. Assembling of Bolster plate: The third component is the Bolster Plate. Similarly the Add component is selected and the Bolster.prt is inserted into the Assembly screen. Here the constraints such as Mate and align are used to fix the model on the bed and it is fully constrained.

4. Assembling of Die Set: The fourth component in the assembly of power press is Die set. Similarly the Die set is inserted; it is assembled and constrained for degrees of freedom arrest.

5. Assembling of Ram: The next component for the power press assembly is Ram. The ram is fixed in the hole provided in the frame. Here insert option is selected and the axis of the hole and ram is selected. Then mate, align options are used to fully constrain the Ram.

After completion of the Assembly of the Power Press, the model is saved in IGES format, to export the assembled model to Ansys Software. For saving in IGES format, we have to choose Save a Copy option.

Static analysis of power press

Problem Specification

Applicable ANSYS Products:	ANSYS Multi physics, ANSYS Mechanical, ANSYS Structural, ANSYS ED
Discipline:	structural
Analysis Type:	static
Element Types Used:	Solid brick 8 node 45

ANSYS Features Demonstrated: solid modeling including primitives, Boolean operations, and fillets; tapered pressure load; deformed shape and stress displays; listing of reaction forces; examination of structural energy error

Technical specifications of the power press

Hydraulic 'C' Frame Type Presses:

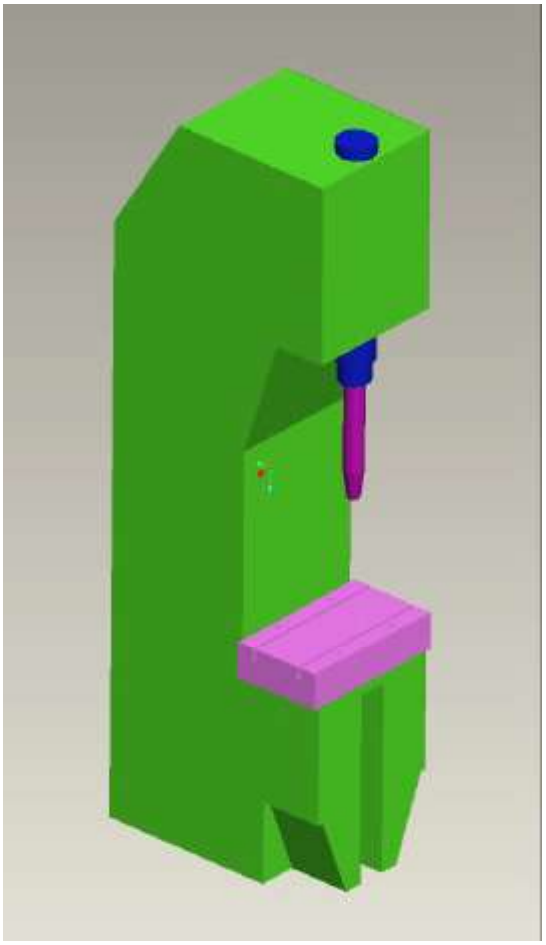
Models	Capacity (Tons)	Piston or Ram Size (mm)	Stroke Length (mm)	Daylight (mm)	Table Size (LxW) mm	Approach Speed (mm/sec.)	Pressing Speed (mm/sec.)	Return Speed (mm/sec.)	Electric Motor (H.P.)	Weight of the Press (Tons)
HCP – 10	10	120	300	350	600×400	30 - 40	5 to 8	30 - 40	5	2 to 2.5

Given:

The material properties of the power press:

Material used	:	Steel
Young's Modulus	:	2.1×105 N/mm2
Poisson's Ratio	:	0.3
Density	:	7860Kg/metres cube
Thermal expansion	:	0.000017

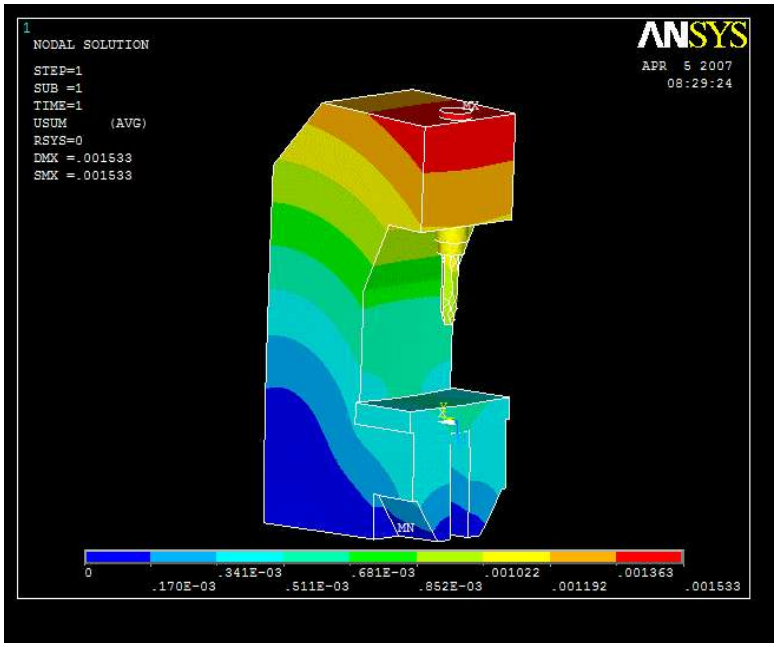
Pro/e Model:



Deflections:

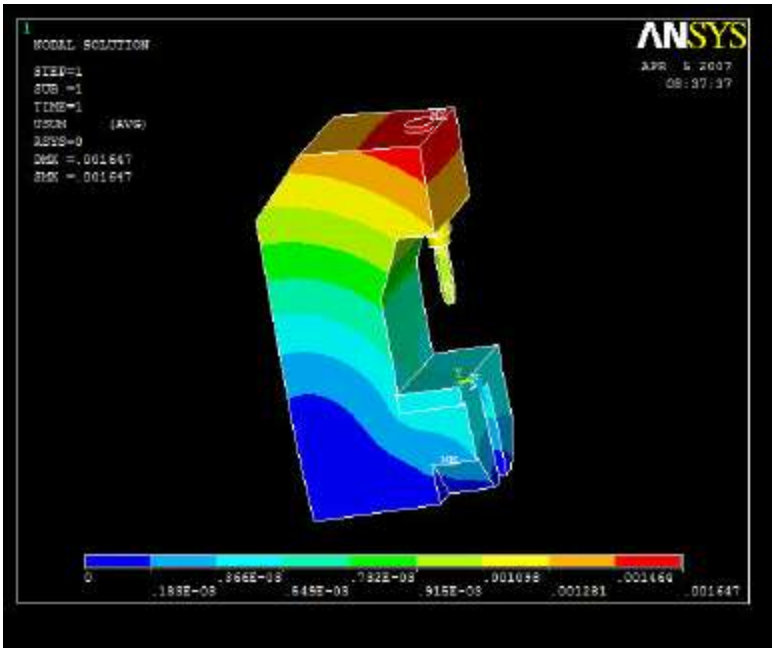
Case 1:

For frame thickness : 25mm
Bed thickness : 100mm



Case 2:

For frame thickness : 18mm
Bed thickness : 70mm

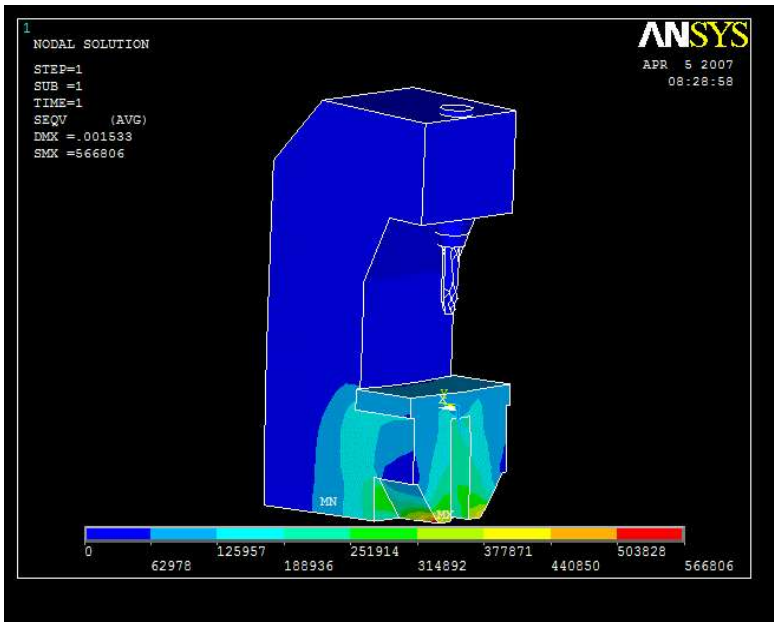


Stress on press:

Case 1:

For frame thickness : 25mm

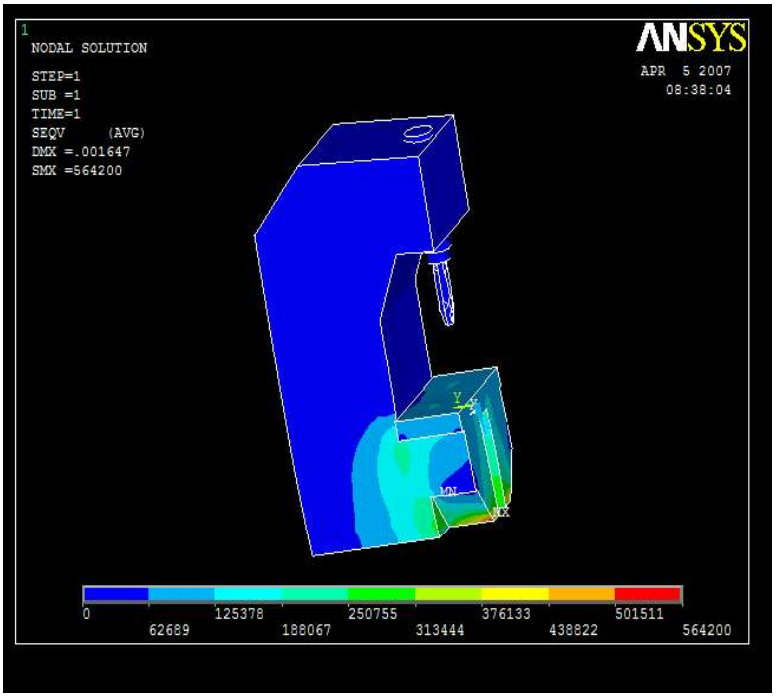
Bed thickness : 100mm



Case 2:

For frame thickness : 18mm

Bed thickness : 70mm



RESULTS

For common load condition: 10 tones

Parameters	Existing	Modified
Bed thickness	100 mm	70mm
Frame thickness	25mm	18mm
Weight	1.92 tones	1.66 tones
Stress	56.68N/mm2	56.42N/mm2
Deflection	1.533mm	1.647mm

In the existing design, the maximum stress acting on the structure is 56.68 N/mm2 and the maximum deflection is 1.533mm. In the suggested design, the maximum stress acting on the structure is 56.42 N/mm2 and the maximum deflection is 1.647mm.

Regarding static analysis, the design is safe. In this design, the decrease in frame and bed thickness is done. So there is a reduction in weight. The reduction in weight is 13.5%. Finally we conclude that this design is the better design.

Existing Mass of the power press: 1920Kgs
Modified Mass of the power press: 1660Kgs

CONCLUSION

In this project the C framed Power Press is studied and the design was done as per the dimensions. The model of the power press is done in PRO/ENGINEER software. The analysis of the power press is carried out using ANSYS package. Analysis was done for power press by reducing its frame thickness, web thickness, and bed thickness. The result obtained from analysis package is within the limit.

REFERENCES

1. ANSYS Verification Manual version 9.0.
2. Khurmi, R.S. and J.K. Guota. Machine Design, EURASIA publishing house.
3. Prabhu, T.J., 2002. Design of Transmission Elements, V Edition.
4. Psg design data book, DPV printers, Reprinted May 2001.
5. Sham Tickoo. A guide to Pro/E wildfire', Purdue University Calumet, U.S.A.