Implementation of CATIA V5 in Modeling and Simulation of Workbench Vice

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Abstract – Workbench vice is commonly used apparatus in mechanical workshops. It has fixed and movable jaws with parallel alignment. In and out movement of the movable jaw is regulated using threaded screw and lever. A design process utilizes, prepares and processes a lot of data to envisage the appearance and expected behavior of the entity during operation. A 3D model design process not only saves time but also creates interactive designs for various applications. The design of bench vice plays a crucial role in several operations. In this paper, computer-aided design (CAD) software was used for modeling and simulation of the workbench vice. The model was made in the CAD package CATIA V5. CATIA is a very intuitive 3D CAD/CAM framework with the capacity to produce solid modeling. The bench vice model is represented by segments, which are connected by different types of joints. The model was made up of 3D solid segments with 6 (3 translation and 3 rotation) degrees of freedom. The profiles of different sections used for the model were solids and combinations of solids of different types such as a cylinder, cuboid, sphere, cylinder/cuboid prism etc. Geometric modeling and assembly of different sections of bench vice were performed in sketcher and part/assembly design tool. The kinematic analysis was conducted in DMU kinematics simulator.

Index Terms – CATIA, CAD, CAM, DMU.

1. INTRODUCTION

CATIA V5 is CAD/CAM/CAE/PLM integrated software, widely used from Aerospace and Defense, Automobile and Industrial equipment, Shipbuilding and other industries. There are number of applications of CAD/CAM software and the most widely used application is Geometric Modeling. Geometric modeling is a branch of applied mathematics and computational geometry in which we studies methods and algorithms for the mathematical description of various shapes. The Graphical Representation of mechanical components using Geometric modeling having wider importance. Basic Geometric modeling techniques are 2D projection, wireframe modeling, surface modeling and solid modeling. In this process of Geometric modeling computer converts commands provided by CAD/CAM software into mathematical models and displays them as image. There are various steps involved in design of Geometric models with the help of CAD Software; first we create basic Geometric objects with the help of basic

commands like point, line, circle, rectangle etc. then we do transformation of these elements using transformation commands like scaling, rotation etc. and finally we use various commands for integration of elements of the Geometric model to form desired product. Here we present Geometric modeling parts and assembly of Workbench vice in CAD Package CATIA V5.

A Workbench vice is used to hold an object to allow work to be performed on it. It consists of two parallel jaws, one is fixed and other is movable. In and out movement of the movable jaw is regulated using threaded screw and lever. Workbench vice provides stability to perform an operation with precision. It can be made of wood or metal depending upon its application.
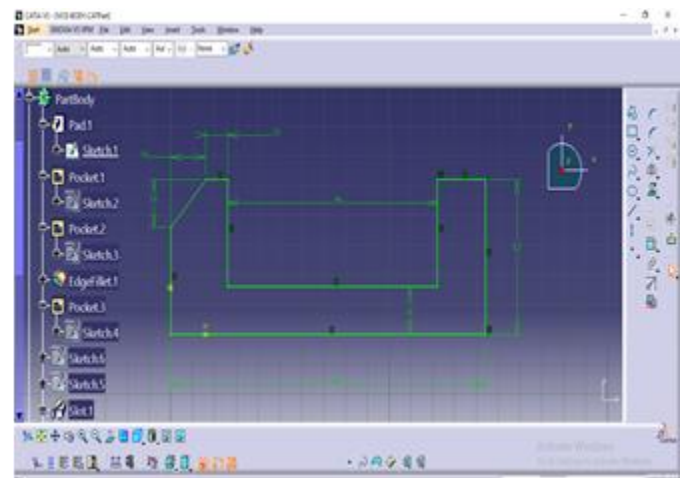
2. GEOMETRIC MODELING OF WORKBENCH VICE

Figure 1. Vice body of Workbench vice in sketcher module.

In Geometric modeling first start by using Part design module. The model was established by using *sketcher* to generate basic elements of Workbench Vice in 2D. It consists of creating rectangles, constraints, making holes, threading, shafting contours, linear copy and circular copy. First we draw the base model of vice with the help of *profile, line, circle, constraint, pad, hole, and rectangular pattern*. The basic contour of base model was created with the help of *profile* and *pad* command.

Then we use *rectangle, circle, pad and pocket* tool to draw fixed jaw on one end of Vice body and other profile on other end to establish complete Vice body of workbench vice. We use *Constraint* tool to define all the dimensions of vice components in 2D. (Fig 1) *Pad and pocket* command was used to form the Vice body model of Workbench vice in 3D modeling (Fig. 2).

In vice body we created internal threads as shown in Figure 2 with the help of *helix* command. Helix is available only in generative shape design. The pitch of the thread is 2mm. the profile of the thread created in the sketcher. Slot command is used to remove the material in slot, we have three options in profile control i.e. keep angle, pulling direction and reference surface. Exact thread can be generated with pulling direction only.
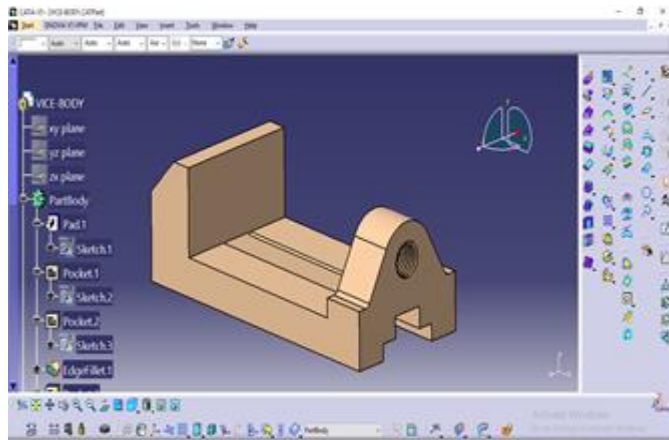

Figure 2. Vice body of Workbench vice in part design module

In the same way Movable Vice jaw of Workbench vice was created separately with the help of *profile, circle, rectangle, pad and pocket* tool. (Fig. 3a and 3b). In geometric modeling we first create base of jaw using *profile* command and then use *pad* command to establish it. We use *pocket* command to for creating holes and before using this command we have to create profile on the surface of jaw.

Figure 3a. Model of movable vice jaw in Sketcher Module

Top hole is created with the help of Hole command. There is difference between pocket and hole command. Hole command is used to create simple, tapered, counter bored, counterwork and counter drilled. Bottom of die hole can be flat and V-bottom. For V-bottom, we can select any degree.
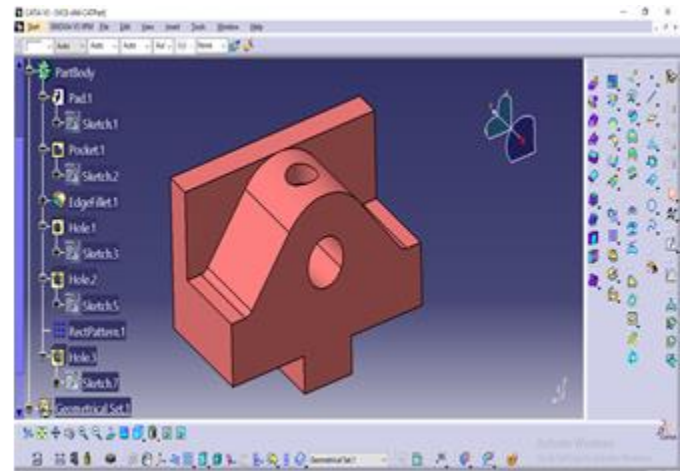

Figure 3b. Model of movable vice jaw in part Design module

In next step in geometric modeling of Workbench vice is to create base plate (Figure 4.) and Sliding jaw stop (Figure 5.) by using *rectangle, circle, pad and pocket* tool. First we draw base with the help of rectangle tool and then use pad command to convert it into 3D. We use *pocket* command to cut holes and before using this command we draw profile of hole in sketcher and constraint it by using *constraint* tool. In pocket command we cut hole throughout the depth of base component.
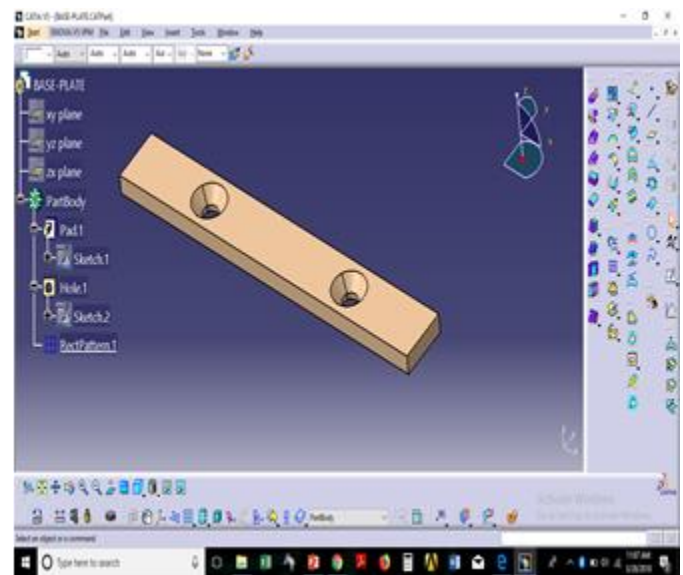

Figure 4. Base plate of Workbench vice in part module

Countersunk is created with the help of hole command. Then rectangular pattern is used to create other hole.
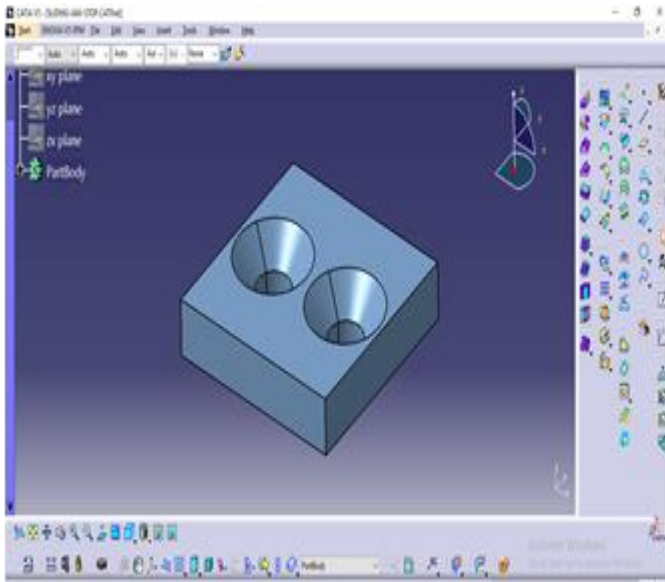
Figure 5. Sliding jaw stop of Workbench vice in part module.

In similar way geometric modeling of Jaw-screw (Figure 6.) and Screw bar (Figure 7.) of Workbench vice is done with the help of sketcher and part design module

We use *profile, line* and *hole* command to create profile in 2D then with the help of shaft, thread, pad and pocket command to convert in 3D in part design. Hole command is used to create threaded holes and then we use circular pattern to make a copy of threaded holes. External thread of jaw screw created with the same pattern as of internal thread of vice body.
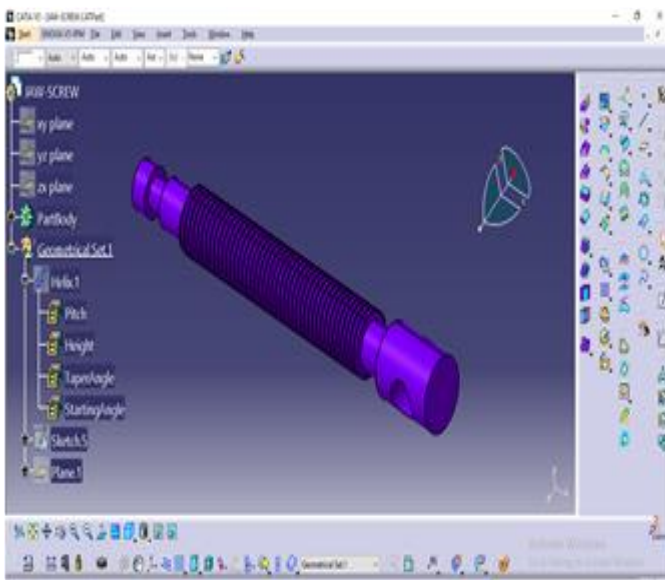

Figure 6. Jaw-Screw of Workbench vice in part module
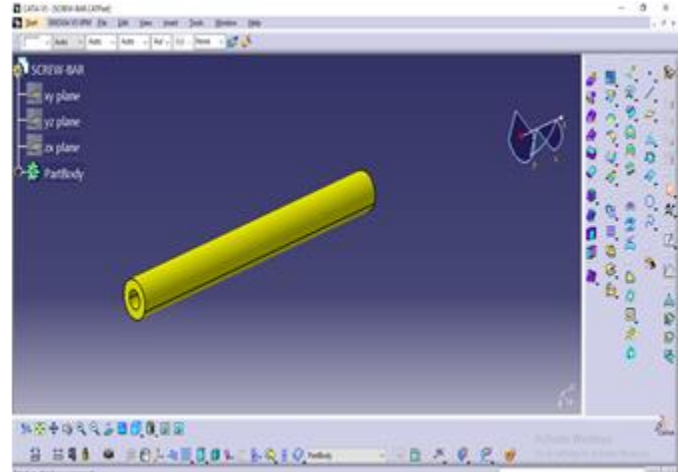

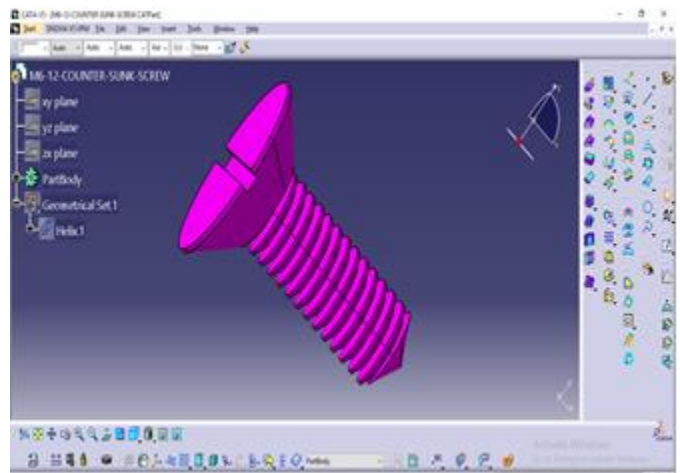Figure 7. Screw Bar of Workbench vice in part module

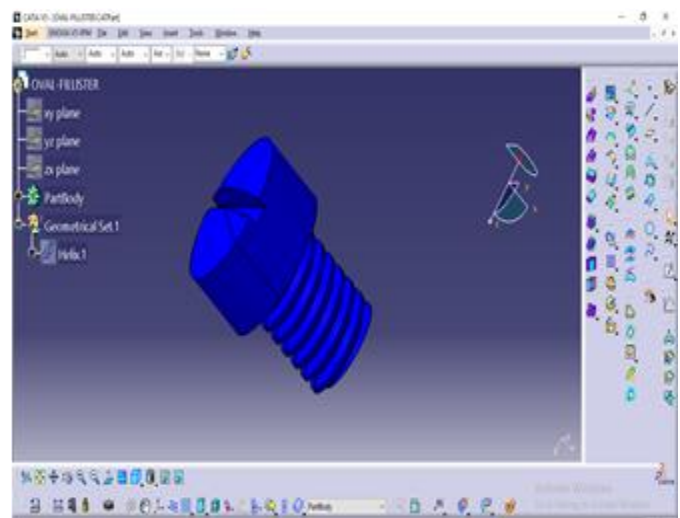Figure 8 Set-Screw of Workbench vice in part module

Figure 9 Oval Fillister of Workbench vice in part module

Geometric modeling of Set-Screw and Oval Fillister was done with the help of *line or profile* command , *shaft* command and *threading*. (Figure 8 and Figure 9). After that we draw Bar globe of Bench vice with the help of *circle, pad* and pocket tools using sketcher and part module. (Figure 10)
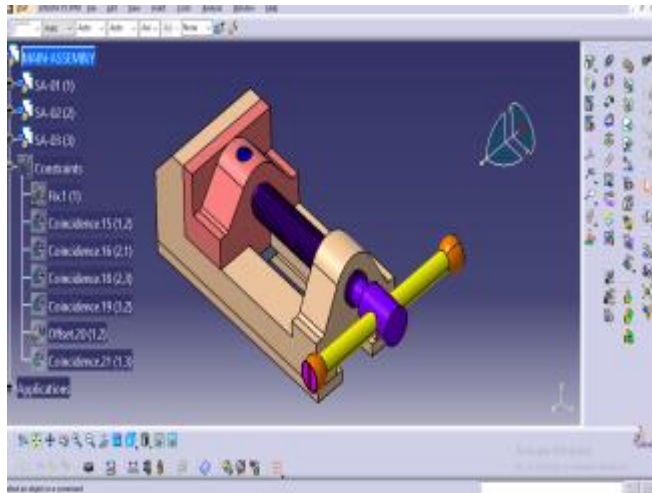

Figure 10. The final appearance of Workbench vice in Assembly Design Module
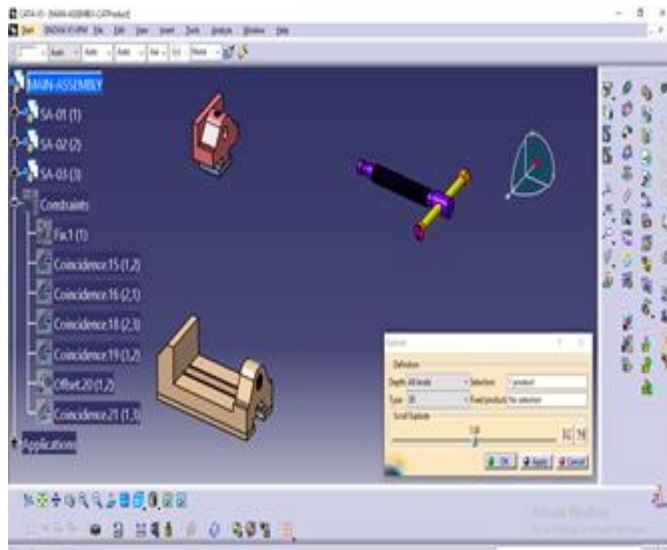

Figure 11. Sub-Assembly of workbench vice

3. WEIGHT OF WORKBENCH VICE

There are 18 parts in workbench vice including hardware. We apply steel material in each part to check the weight of the assembly. Measure inertia is used to check the weight of each component of assembly. Weight of Assembly is shown in Table 1 along with weight of each component. Total weight of assembly is 2.432 kg.

S.No	Part Name	Material	Density (gm/cm^3)	Weight (kg)	Quantity
1	Vice Body	Steel	7.86	1.365	1
2	Vice jaw	Steel	7.86	0.461	1
3	Base Plate	Steel	7.86	0.258	2
4	Sliding jaw stop	Steel	7.86	0.049	1
5	Counter sunk screw	Steel	7.86	0.040	8
6	Jaw screw	Steel	7.86	0.18	1
7	Oval fillister	Steel	7.86	0.004	1
8	Screw bar	Steel	7.86	0.057	1
9	Bar guage	Steel	7.86	0.018	2

Table 1. Weight of the components of Bench vice.
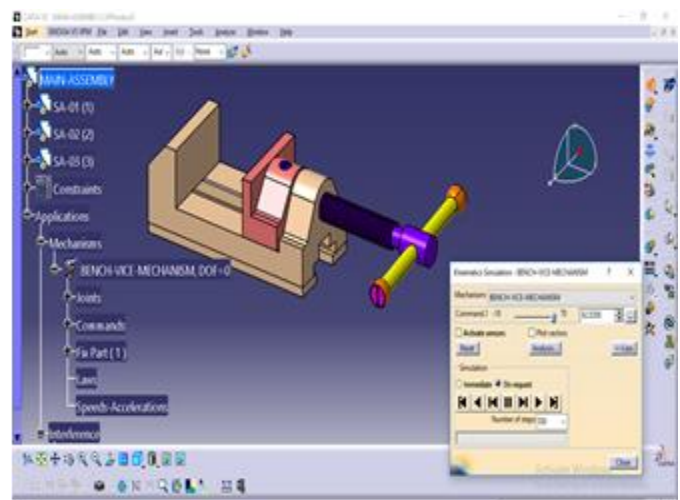
4. SIMULATION OF WORKBENCH VICE

Figure 12. Simulation of Workbench vice in DMU kinematics

After assembly of workbench vice we perform simulation with the help of Digital mockup (DMU) Kinematics. Before simulation first we define various joints between components i.e. planar joint between vice jaw and vice body, screw joint between vice body and jaw screw. After providing constraints in motion with the help of joints, we perform simulation of workbench vice as shown in Figure 12. We can also use Assembly conatraint conversion to set compounds automatically on the basis of existing constraints.

5. CONCLUSION

The model of Workbench vice was made in the CAD package CATIA V5. CATIA is a very intuitive 3D CAD/CAM framework with the capacity to produce solid modeling. Geometric modeling and Simulation was done with the help of Part Design Module, Assembly Design Module and DMU Kinematics Simulator. All these modules were integrated in one unit of CATIA V5. In Part Design if we change dimensions or design of component, it will automatically update in final assembly of product. Assembly Design module help us to assemble the final product from its components with the help of various flexible tools. In this CAD package we start working from base components and complete with the simulation of final product. Here we do kinematics analysis of product in DMU Kinematics, while Dynamic analysis is not possible.

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