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Computer Aided Design of Kaplan Turbine Piston with SolidWorks

The paper presents the steps for 3D computer aided design (CAD) of Kaplan turbine piston made in SolidWorks.The present paper is a tutorial for a Kaplan turbine piston 3D geometry, which is dedicaded to the Parts Sketch and Parts Features design, figure 13, and Drawing Geometry and Drawing Annotation,figure 1.

Keywords: *Kaplan turbine piston, SolidWorks, 3D geometry*

1. Introduction

The Kaplan turbine piston has a complex 3D geometry, figure 1, which must be generated in a CAD software for the final drawing and for finite elements strenght calculus. As a CAD software was chosen SolidWorks [1]. The procedure of Kaplan turbine piston CAD modeling is described step by step.
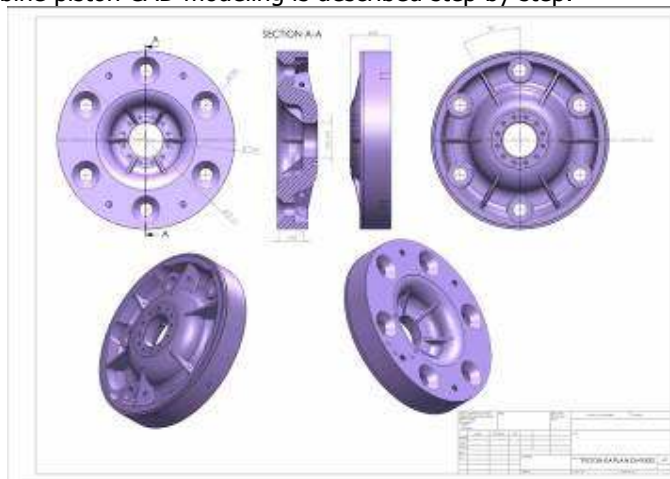

Figure 1. The main dimensions of the Kaplan turbine piston

2. The base contour revolution

The first step is to draw the sketch of the base contours, figure 2, in the **Front Plane.**The **Revolve** command will generate the 3D geometry of the body, by revolving the complete contour around the horizontal symmetry axe, figure 3.
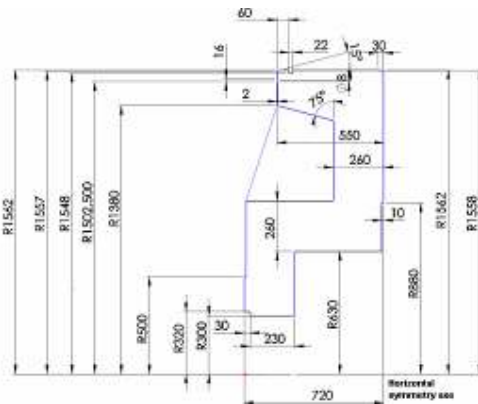

Figure 2. The base contour sketch   **Figure 3.** The revolution body

3. The holes Φ230 mm diameter

In the inferior face plane will be sketched the circle with 2600 mm diameter. On this diameter will be sketched the circle with 230 mm diameter.

The symmetrical six circles with 230 mm diameter will be generated by **Circular Sketch Pattern** command , figure 4.

The holes with 230 mm diameter will be generated with **Features / Extruded Cut** command and **Through All** option. With the **Features/Chamfer** command will be constructed the chamfer 130x45^0 for these holes, figure 5.

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Figure 4. The 230 mm diameter circles

Figure 5. The Φ230 mm cuts
and the 130x45^0 chamfer

4. The chamfers and fillets of the revolution body

With the **Chamfer** command will be constructed the 11x45^0 chamfer on the cylinder with 640 mm diameter, the 2x45^0 chamfer on cylinder with 600 mm diameter and the 1x45^0 chamfer on cylinder with 3124 mm diameter.

With the **Fillet** command will be constructed all the rounding surfaces, figure 6.

Figure 6. The chamfers and fillets of the revolution body

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5. The ribs of the superior face and the ribs of the inferior face

With the **Features/Reference Geometry/Axis** command will be generated the axis of the revolution body.

With the **Features/Reference Geometry/Plane** command will be generated a working plane inclined at 30 degrees to the Front Plane. In the working plane the sketch of the ribs is drawn on the inferior face and the superior face, figure 7.
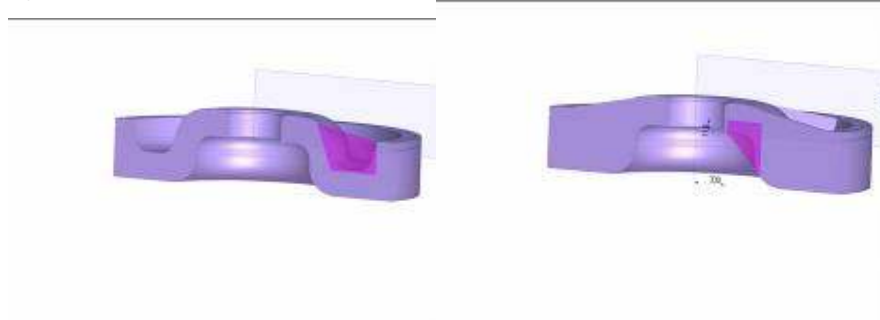

Figure 7. The sketch of the ribs of the superior face and the inferior face

The ribs will be generated with the **Extruded Boss/Base** command on 50 mm distance to the **Mid Plane** for the ribs of the superior face and on 25 mm distance to the **Mid Plane** for the ribs of the inferior face.

The construction draft for the ribs will be generated with the **Draft** command. With the **Fillet** command will be constructed all the rounding surface of the ribs R10 and the rounding surface R25 between the revolution body end ribs.

The symmetrical six ribs will be generated by **Circular Pattern** command.

Four cuts of the ribs on the superior face will be sketched using circles of 100 mm diameter.

The holes with 100 mm diameter will be generated with **Extuded Cut** command and **Through All** option.
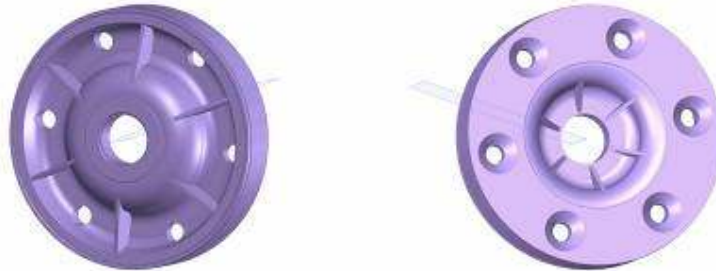
The construction of the ribs is showed in figure 8.

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Figure 8. The construction of the ribs

6. The holes Φ50 and the threaded holes M80x4

In the superior face plane will be sketched the circle with 820 mm diameter. In two opposite points will be sketched two circles with 50 mm diameter.

The Φ50 cut will be generated with **Extruded Cut** command on 80 mm depth. On the 820 mm diameter circle, the circle with 76 mm diameter will be sketched with axis inclined at 15 degrees from the vertical axis.

The symmetrical twelve circles with 76 mm diameter will be generated by **Circular Sketch Pattern** command.

The threaded holes M80x4 will be generated with the **Insert/Annotations** command and **Cosmetic Thread** option, with 120 mm depth, figure 9.

With the **Chamfer** command the chamfer $3x45^0$ will be constructed for the M80x4 threaded holes.

Figure 9. The holes Φ50 and the threaded holes M80x4

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7. The threaded holes M100x6

In the inferior face plane will be sketched the circle with 2600 mm diameter. On the 2600 mm diameter circle will be sketched the circle with 94 mm diameter, with axis inclined at 30 degrees from the vertical axis.

The symmetrical four circles with 94 mm diameter will be generated by **Mirror Entities** command. The Φ96 cuts will be generated with **Extruded Cut** command on 200 mm depth. The same steps will be followed for Φ115 cut on 17 mm depth.

The threaded holes M100x6 will be generated with the **Insert/Annotations** command and **Cosmetic Thread** option, with 180 mm depth, figure 10.

Figure 10. The threaded holes M100x6

8. The Φ420 top cylinders

The construction of the top cylinders with 420 mm diameter is shown in figure 11. On the 2434.7 mm diameter circle will be sketched a circle with 420 mm diameter and a concentric circle with 230 mm diameter.

The **Extruded Boss/Base** will generate the 3D geometry of the top cylinder by circle extrusion on 55 mm distance.

The same steps will be followed for the extrusion cylinder with 420 mm diameter between the superior face and top cylinder.

With the **Fillet** command will be constructed the fillets R5 and R30 for top cylinder.

Figure 11. The construction of the top cylinders

9. The final Kaplan turbine piston 3D geometry

The final 3D geometry of the Kaplan turbine piston is presented in figure 13. The steps followed to obtain the geometry (**The Browser Bar**) are presented in figure 12. The **Browser Bar** is a history of the modeling process.
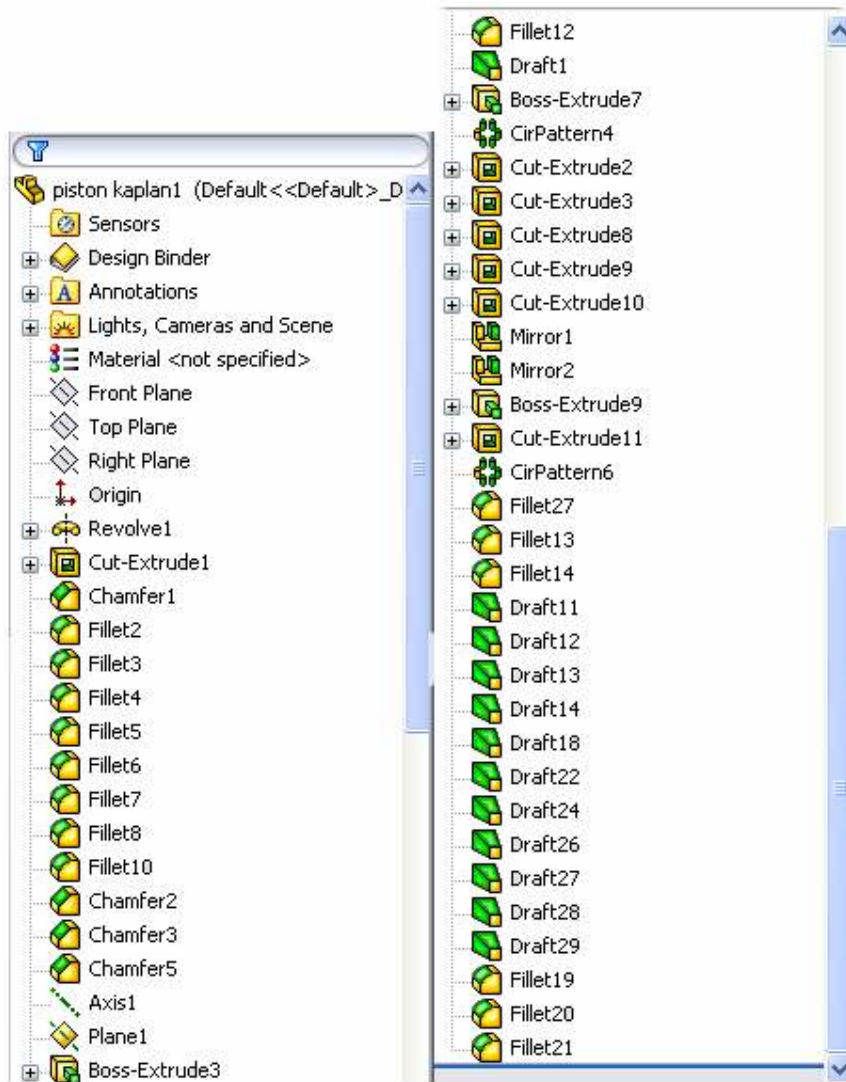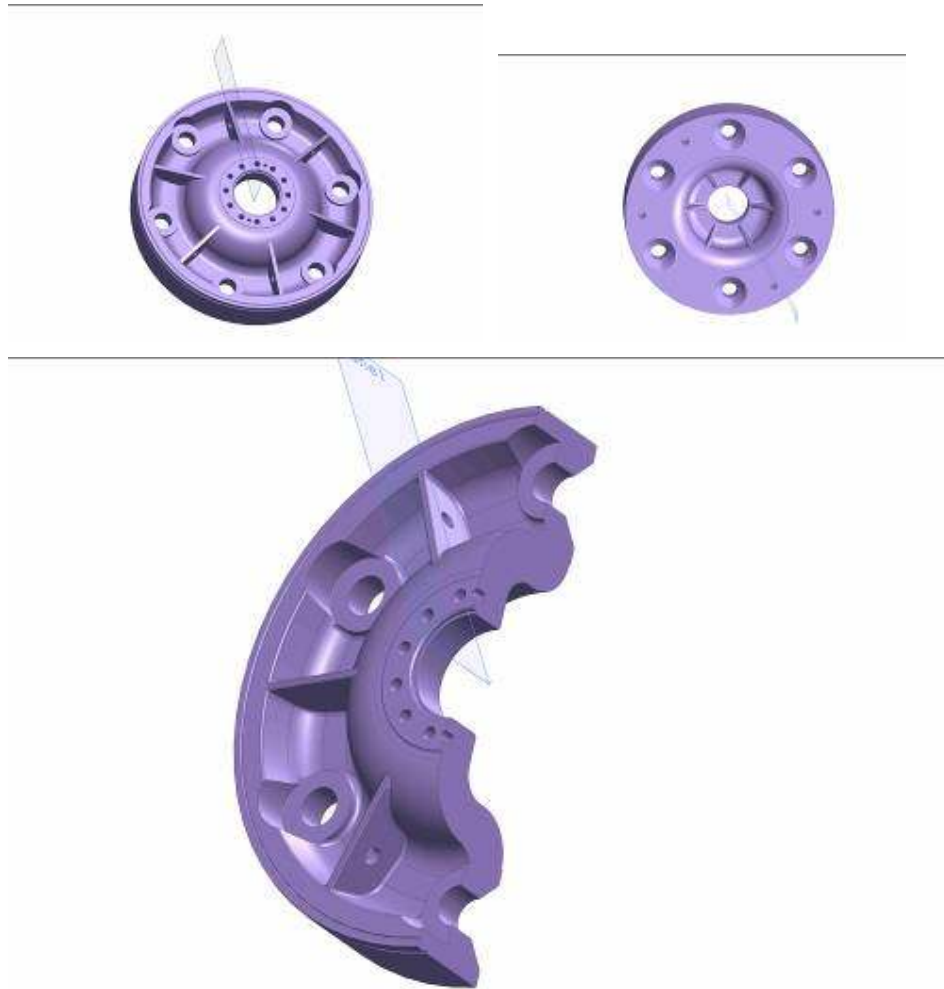
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Figure 12. The Browser Bar

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Figure 13. The Kaplan turbine piston 3D model

10. Conclusions

SolidWorks is a powerful CAD software for 3D geometry modeling, which can be used for: Parts Sketch, Assemblies, Drawing Geometry and Drawing Annotation, Weldments, creating Adaptive Parts, creating Derived Parts, Motion Presentation of the Assemblies, CosmosMotion and CosmosWorks, Stress Analysis.

The Kaplan turbine piston will be analyzed with finite element method, with CosmosWorks, to obtain stress distribution [2], [3].

References

[1]   ***** *SolidWorks 2009 Bible* Published by Wiley Publishing, Inc, Indianapolis, Indiana,ISBN:978-0-470-25825-5.

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[3]   Mănescu T.Ş.,Nedelcu D., *Analiză structurală prin metoda elementului Finit,,* Timişoara, Orizonturi Universitare, 2005.

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