SCIENTIFIC BULLETIN OF
THE „POLITEHNICA" UNIVERSITY OF TIMISOARA, ROMANIA
Transactions on MECHANICS
BULETINUL ŞTIINŢIFIC AL
UNIVERSITAŢII "POLITEHNICA" DIN TIMIŞOARA, ROMANIA
SERIA MECANICA
Tom 52 (66) **ISSN 1224 - 6077** **Fasc. 5, 2007**

COMPUTER AIDED DESIGN OF AN DRAFT TUBE'S ELBOW FOR HYDRAULIC TURBINE USING MICROSTATION

Dorian NEDELCU
Universitatea "Eftimie Murgu" din Reşiţa, Facultatea de Inginerie, P-ţa Traian Vuia No. 1-4, Reşiţa, +40-0255-219134
E-mail: d.nedelcu@uem.ro, România
Ioan PĂDUREAN
Universitatea "Politehnica" din Timişoara, Facultatea de Mecanică, B-dul Mihai Viteazu No. 1, 1900 Timişoara, tel. +40-256-403681, E-mail: padurean58@yahoo.com, România

Abstract: *The draft tube's elbow of the hydraulic turbine is an important hydrodynamic element, with the function to lead the water from the runner to the exit and the transformation of the kinetic energy to potential energy. The elbow has a complex geometry, which must be generated in a CAD software for the final drawing. As a CAD software was chosen Microstation [1], [2], [3], [4]. There are described step by step the procedure of elbow CAD modeling.*

Keywords*: CAD, elbow, turbine, Microstation.*

1. Introduction

Usually, there are known or can be obtained, from hydrodynamic calculus, the 3D coordinates of elbow sections, figure 1. The first elbow section **2** is a circle and the last section **9** is a rectangle with rounded corners. Between the first and the last section, the sections are variable. The elbow from figure 1 has 8 sections; the dimensions correspond to the inner side of the sections.

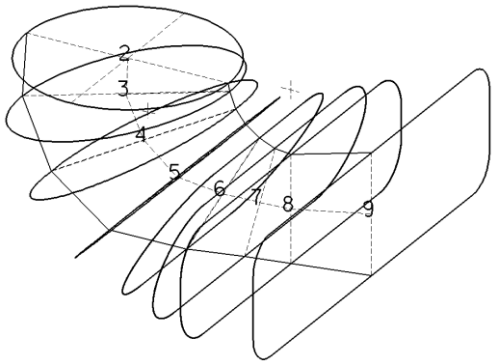

Fig. 1 The elbow sections

2. Construct the ring between two sections

To generate in Microstation the ring between two sections with variable dimensions as solid object, must be used **Skin Solid Feature** command. This command uses two or more closed loops, and will generate the corresponding solid. The solid is a 3D computer representation of the real object. In the case of the elbow there will be generate the ring between every two sections, because the sections geometry are too complex to generate a single solid from all sections. Finally we will obtain seven rings. There will be exemplified the ring generation between the sections **2** and **3**, figure 2.

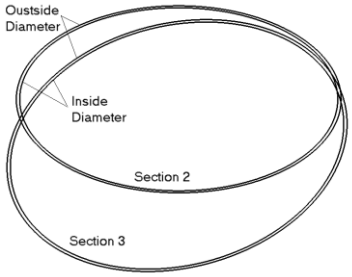

Fig. 2 The sections no. 2 and 3

The process consist of three step:

- first step is to generate the solid based on the outside diameters of section 2 and 3, with command **Skin Solid Feature**, figure 3;

▪ the second step is to generate the solid based on the inside diameters of section **2** and **3**, with command **Skin Solid Feature**; the result is visual similar with figure 3, except the last solid is included in the first solid;

▪ the last step is to generate the solid ring as boolean difference between the first and second solid, with the command **Difference Feature**, figure 4;

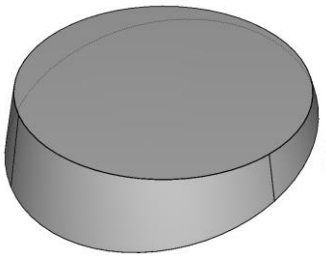

Fig. 3 The solid between sections no. **2** and **3**

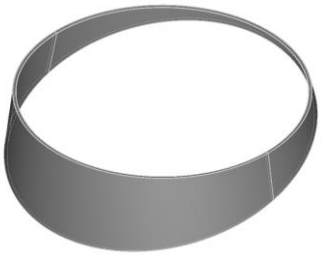

Fig. 4 The ring solid between sections **2** and **3**

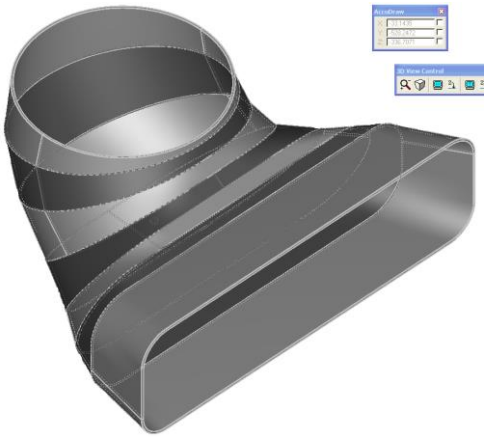

Fig. 5 The elbow's rings

3. Construct the circular ribs

The elbow must be a rigid body. Therefore, circular and longitudinal ribs will be applied. The process to generate a circular rib is similar with steps described in &2, because a rib is generated by two section with outer and inner diameters. For this particular elbow will be applied three circular ribs, to the section **4**, **6** and **8**, figure 6.

4. Construct the longitudinal ribs

The geometry of the longitudinal ribs is not identical. To construct a rib, must be sketched the median profile of the rib and extrude the closed profile to obtain the thickness. The **Extrude Feature** command is used. The final result is done in figure 6.

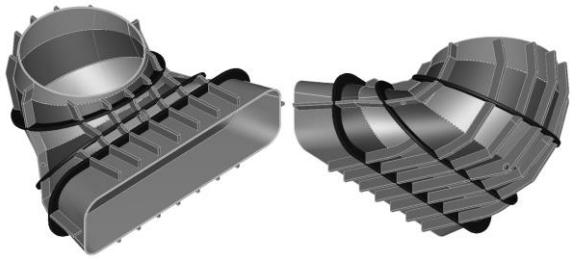

Fig. 6 The longitudinal and circular rings

5. Construct the upper flange

The upper flange makes the connection with draft tube cone. The solid flange can be generate in two ways:

▪ by extruding the circle with radius **R1** on **h1** distance, followed by extruding the circle with radius **R2** on **h2** distance, using **Extrude Feature** command is used; the union of two extrusion with **Union Feature** command, will generate a single solid; finally, the central hole, will be generate by command **Cut Feature**, having the circle with **r** radius as cutting profile and the solid as target;

▪ by rotating the transversal profile around the vertical draft tube axis, using **Revolve Feature** command, figure 7; of course, this second method is more easy and quickly; also the solid will be generate from a single command, avoiding the three command from the previous method.

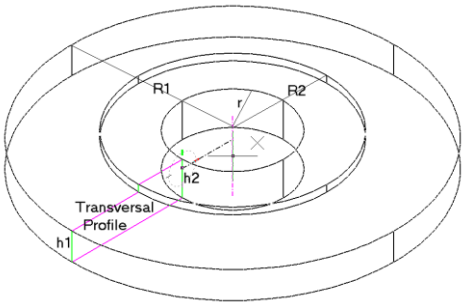

Fig. 7 The upper flange

Next, in the flange must be manufactured the catch holes. The command **Hole Feature** will be used, specifying the hole and depth diameter and the precise location of center's holes.

With the same command will be generate the hole for the future bossage attached to the draft tube (see &7).

The final result is presented in figure 8.

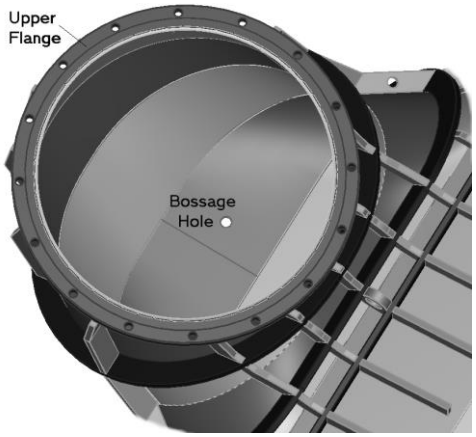

Fig. 8 The upper flange as a 3D solid geometry

6. Construct the exit flange

The outer side of the exit flange has a rectangular shape, with rounded corners. Also, the inner side has the same shape, with others dimensions. The thickness is a constant value. First will be drawn the outside closed contour, followed by the drawing of the inner closed contour. With **Create Region** and option **Difference** will be generate the region resulted as a boolean difference between the outer and inner contour. The flange is obtained by extruding this region with the value of the flange thickness. Next, in the flange must be manufactured the catch holes by using the command **Hole Feature**.

The final result is presented in figure 9.

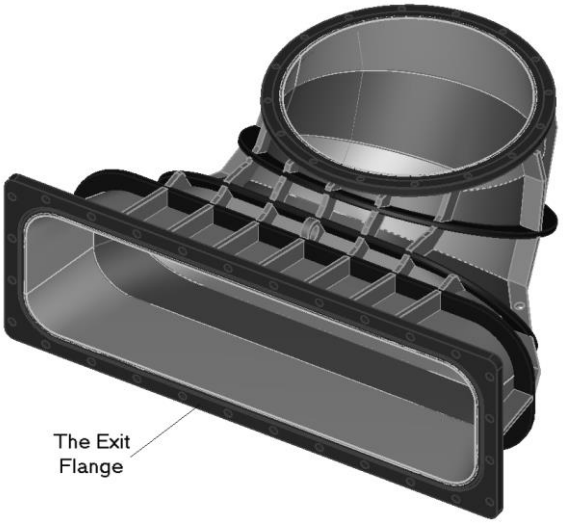

Fig. 9 The exit flange as a 3D solid geometry

7. Construct the bossage

The bossage is obtained as a rotating geometry, with **Revolve Feature** command, figure 10.

8. Construct the ribs of the sill

To construct the two sill ribs, must be sketched the median profile of the rib and extrude the closed profile to obtain the thickness. The **Extrude Feature** command is used. The ribs of the sill geometry must be connected with the rings and circular ribs geometry. The final result is done in figure 10.

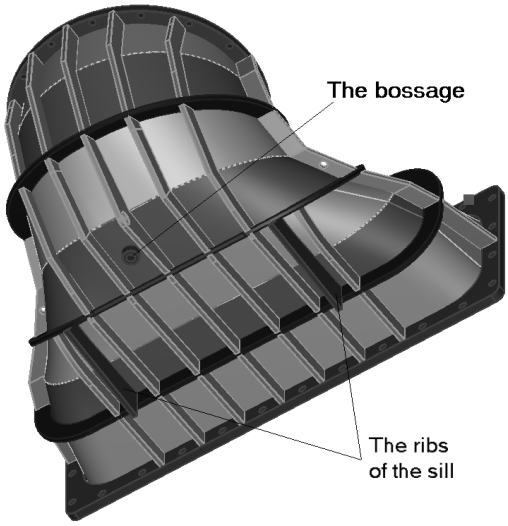

Fig. 10 The bossage and the ribs of the sill

9. Construct the sill

To construct the sill, must be sketched the median profile of the sill and extrude the closed profile to obtain the thickness. The **Extrude Feature** command is used. Next, in the sill must be manufactured the central hole by using the command **Hole Feature**. The sill is used to put the elbow in a horizontal plane.

The final result is done in figure 11.

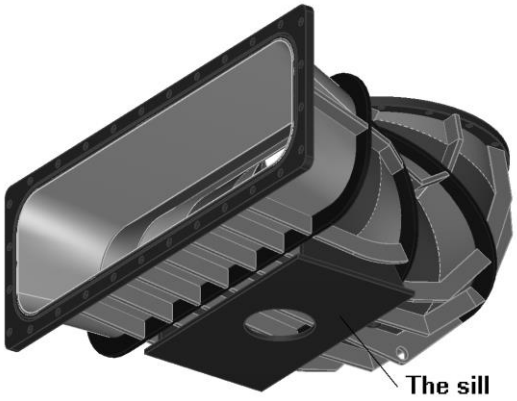

Fig. 11 The sill

10. The elbow drawing

The final drawing of the elbow is presented in figure 12 and figure 13. The figure 14 show an isometric view of the elbow with the sill and sill ribs removed.

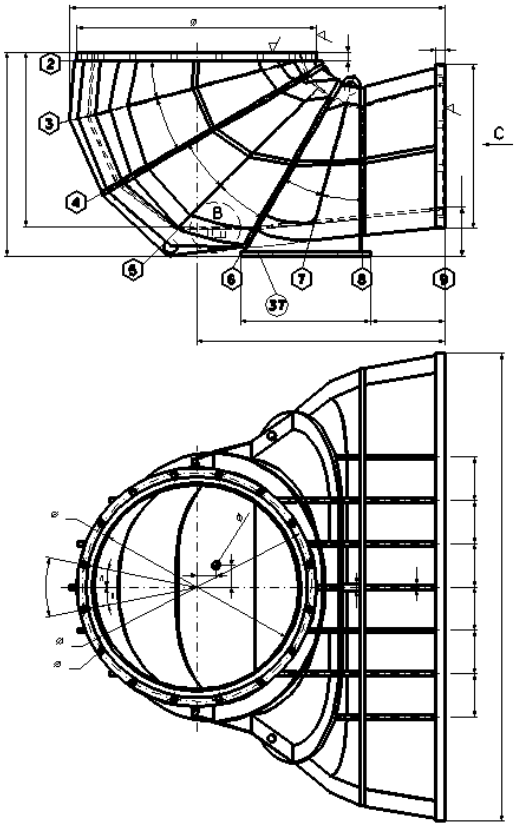

Fig. 12 The front and the top view of the elbow

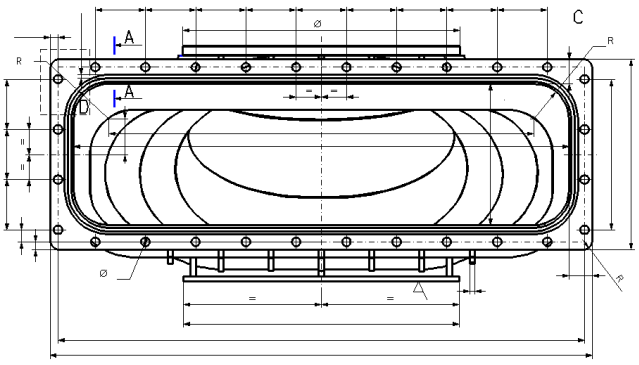

Fig. 13 The side view of the elbow

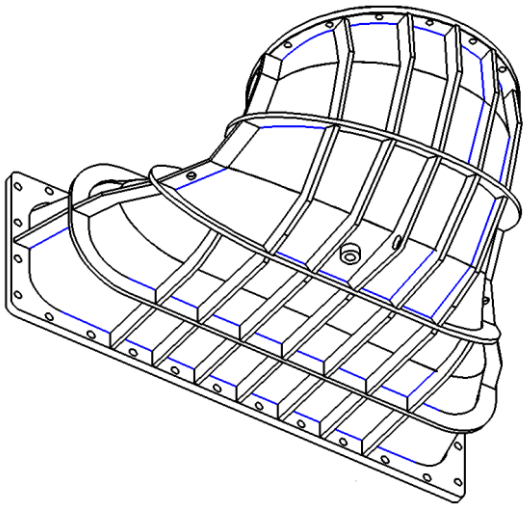

Fig. 14 The isometric view of the elbow

References

1. **Nedelcu, D.,** - *Proiectarea asistată de calculator prin Microstation*, Editura "Orizonturi Universitare", Timişoara, 2001.
2. **Nedelcu, D.,** - *Aplicaţii 2D / 3D de proiectare asistată de calculator*, Editura "Orizonturi Universitare", Timişoara, 2003.
3. **Dragomir, D.** – *Proiectarea cu Microstation 95*, Editura "Evrika", Brăila, 1999.
4. **Nancy, A. Olson** – *Microstation 95 Fundamentals*, New Riders Publishing, Indianapolis, 1996.

PROIECTAREA ASISTATĂ DE CALCULATOR A CONULUI TUBULUI DE ASPIRAŢIE A UNEI TURBINE HIDRAULICE UTILIZÂND MICROSTATION

Rezumat

Geometria conului tubului de aspiraţie a unei turbine hidraulice este complexă. Pentru generarea desenelor de execuţie şi pentru calcule de rezistenţă cu elemente finite, geometria paletei trebuie generată ca reprezentare solidă. Lucrarea prezintă procedura utilizată pentru conului tubului de aspiraţie a unei turbine hidraulice, utilizând programul de proiectarea asistată de calculator Microstation.

Referenţi ştiinţifici: Prof. dr. ing. Mircea POPOVICIU
Prof. dr. ing. Victor BĂLĂŞOIU