Buletinul Ştiinţific al Universităţii "POLITEHNICA" din Timişoara

Seria HIDROTEHNICA

TRANSACTIONS on HYDROTECHNICS

Tom 58(72), Fascicola 2, 2013

Theoretical and Applied Aspects of Axonometric Representations

Stela IONIŢĂ[1] Dumitru MARIN[1] Ionuţ –Valentin RADU[1]

Abstract: The papers describes ways of direct passage from double (triple) of orthogonal projection of an object, to axonometric projection using methods of transforming projections (change of plane, rotation, coincidance method) while establishing grafo-analytic relationship between the two types of projection. Depending on the chosen methodes one can achieve programmes of automatic drawing of axonometric reprezentation.

Keywords: axonometric, isometric, dimetric, reduction coefficient, axonometric plan, axonometric axes.

1. INTRODUCTION

The axonometric representation of an object (part) is the orthogonal (or skewed) projection of an object on a plan (inclined to the axes of trihedral reference) called axonometric plan.

The literature has many ways of passing from double / triple orthogonal to the axonometric projection, among them is the use of projection transformation methods (changing planes of projection, rotation and vertical downwards inclination of geometric elements).

2. AXONOMETRIC REPRESENTATION BY FOLDING AND ROTATION OF THE AXONOMETRIC PLAN ON THE VERTICAL PROJECTION PLAN

Whether axonometric plan [P] represented in figure 1 by its traces and point Ω (ω, ω ') the projection origin trihedral on the axonometric plan. By the vertical downwards inclination plan [P] on plan [V], an equilateral triangle $P_xP_zP_{y0}$ with center Ω_0 is obtained. By further rotation of the $P_xP_zP_{y0}$ triangle until P_xP_{y0} side overlaps OX axis, obtaining the new position of the axonometric triangle $P_xP_{yr}P_{zR}$, centered in Ω_R. The segment $P_XO = l$ (or segments of space parallel with P_XO) is projected on the the axonometric plan by the $P_x\Omega_R$ segment. From figure 1 we have the following relationship:

$$P_X\Omega_R = \frac{P_x h_R}{\cos 30^\circ} = l\sqrt{\frac{2}{3}} \cong 0{,}82l \qquad (1)$$

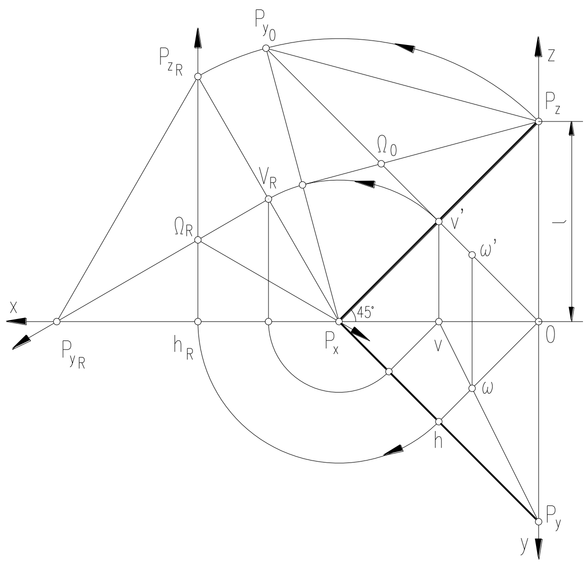

Fig. 1 Folding and rotation of the axonometric plan

Because $P_x\Omega_R = P_{yR}\Omega_R = P_{zR}\Omega_R = 0{,}82\,l$, it can be seen that in all three axonometric axis the same reduction coefficient (0,82) is achieved, the 0,82 value being known from the fundamental formula of the isometric axonometric.

Figure 2 is the axonometric isometric projection of a simple part (hexagonal prism) of which two orthogonal projections are known (Monge define draught), using the method presented above.

The advantages of this method are:

- the part is not distorted as in classical axonometric of 1,22 times (1,22 = 1/0, 82);

- orthogonal representation (possibly quoted) and axonometric provides complex data on the parts to non-specialists.

The disadvantage is that the part appears in the mirror axonometric representation relative to the orthogonal representation, so the method is suitable to be used for symmetric parts.

This disadvantage can be eliminated by a computerized mirroring representation operation.

[1] University POLITEHNICA of Bucharest, Engineering Graphics and Industrial Design Department, e-mail: stela.ionita@yahoo.com; dumarpub@yahoo.com; raduionut@live.com

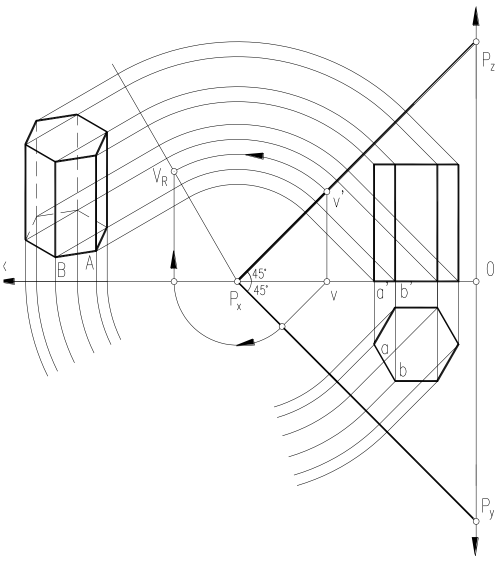

Fig. 2 Axonometric projection of a prism

3. AXONOMETRIC REPRESENTATION BY TWO SUCCESSIVE CHANGE OF PLAN

Whether axonometric plan [P] represented in figure 3 by its traces ($OP_X = OP_y = OP_z = l$) and a square-based prism ABCDEFGH in [H], the side "a" represented in two projections (draught Monge).

After changing the vertical plan (the new vertical plan is perpendicular to the axonometric plan and contains OP_z so $O_1X_1 \perp P_xP_y$) followed by a horizontal plan change (the new horizontal plan being the axonometric plan, therefore $O_2X_2 // hP_{z0}$), we obtain the new horizontal projection of the prism, which is its axonometric projection.

The following relations result from Fig. 3:

$$\angle \overline{O_1X_1}, \overline{OX} = 45° \tag{2}$$

$$\angle\alpha = \angle\left(\overline{hP_{z0}}, \overline{O_1X_1}\right) = arctg\sqrt{2} \tag{3}$$

$$\angle\alpha \cong 54°40' \tag{4}$$

$$\sin\alpha = \cos\beta = \frac{l}{l\sqrt{\frac{3}{2}}} = \sqrt{\frac{2}{3}} \cong 0{,}82 \tag{5}$$

$$\cos\alpha = \frac{\frac{l\sqrt{2}}{2}}{\frac{l\sqrt{6}}{2}} = \sqrt{\frac{3}{2}} \tag{6}$$

Thus, the segment $OP_z = l$ (or other segments parallel with OP_z in space) are projected on the reduced axonometric plan (0,82 *l*), the reduction factor being the same as in the method of paragraph 2, the known value of the fundamental axonometric isometric formula.

$$\overline{b_1c_1} = \overline{b_1a_1} = \sqrt{(b_1\omega_1)^2 + (\omega_1c_1)^2} \tag{7}$$

$$\overline{a_1b_1} = \sqrt{\frac{2a^2}{4} + \left(\frac{a\sqrt{6}}{6}\right)^2}\, a\sqrt{\frac{2}{3}} = 0{,}82a \tag{8}$$

$$\overline{a_1c_1} = a\sqrt{2}\cdot\cos\alpha = a\sqrt{2/3} = 0{,}82a \tag{9}$$

The triangle $a_1b_1c_1$ is equilateral, so axonometric axes will form angles of 120^0.

Depending on the selection method of O_2X_2 axis and the direction of rotation of the plans of projection for the overlap, several solutions can be obtained. In figure 3 there are two solutions (symmetrical with the O_1X_1 axis).

Advantages and disadvantages of this method are the same as those listed in paragraph 2.

If a dimetric axonometric representation of an object is desired, the axonometric plan is represented as in figure 4 ($OP_X = OP_z = l$, $OP_y = l / 2$).

In the two succesive changes of plan, $O_1X_1 \perp P_xP_y$ and $O_2X_2 // hP_{z0}$ are chosen. From the triangle OP_xP_y , the following relations can be calculated:

$$P_xP_y = \frac{l\sqrt{5}}{2}; \qquad Oh = \frac{l\sqrt{5}}{5} \tag{10}$$

$$P_xh = \frac{2l\sqrt{5}}{5}; \qquad hP_{z0} = \frac{l\sqrt{30}}{5} \tag{11}$$

$$\sin\alpha = \frac{\sqrt{20}}{5}; \qquad \cos\alpha = \frac{\sqrt{5}}{2} \tag{12}$$

$$tg\beta = \sqrt{5}\ ; \qquad \cos\beta = \frac{\sqrt{6}}{6} \tag{13}$$

$$arctg\beta \cong 65°55' \tag{14}$$

$$\sin\beta = \frac{\sqrt{30}}{6} \cong 0.92 \tag{15}$$

Thus, segments OP_z and OP_X (or parallel to these) are projected on the reduced axonometric plan (0.92 l), the reduction factor being very close (0.94) to the fundamental dimetric axonometric formula.

From figure 4 we calculate:

$$b_1'c_1' = a\sin\alpha = \frac{a\sqrt{20}}{5} \tag{16}$$

$$a_1'b_1' = a\cos\alpha = \frac{a\sqrt{5}}{5} \tag{17}$$

$$a_1b_1 = \frac{a\sqrt{30}}{6} \cong 0{,}92a \tag{18}$$

$$a_1d_1 = \frac{a\sqrt{3}}{3} \cong 0{,}57a \tag{19}$$

$$\angle\gamma \cong 11°20'\ ;\ \angle\delta \cong 41°20' \tag{20}$$

With the help of “ γ” and “δ”, the axonometric axes angles can be determined for the dimetric representation. Dimetric axonometry has the advantage to render the object image close to reality.

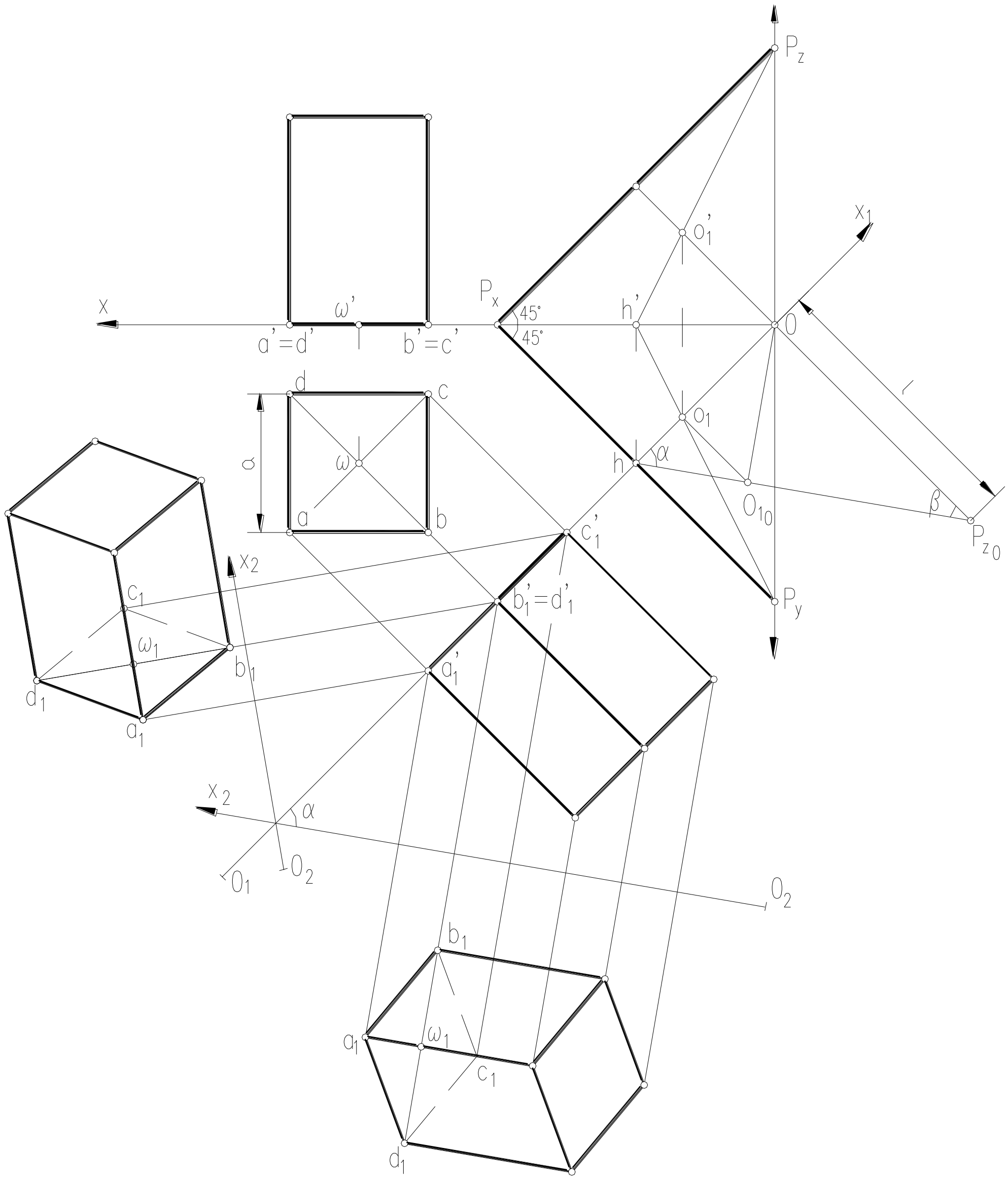

Fig. 3 Isometric axonometric representation by two successive changes of plan

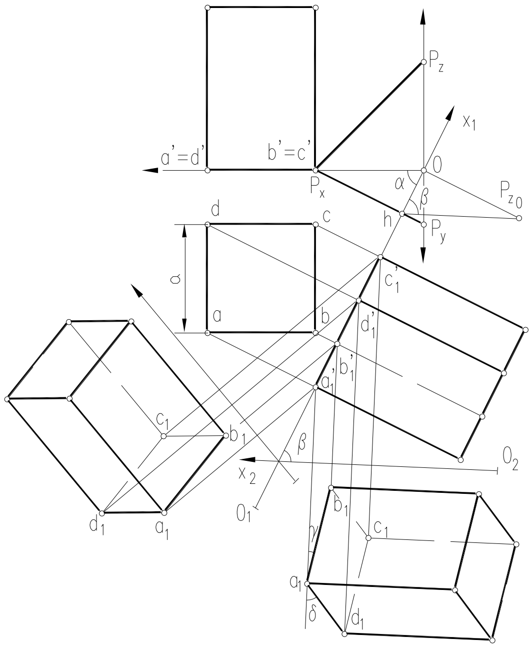

Fig. 4 Dimetric axonometric representation

In figure 5, a computer isometric representation software for a prismatic part is presented.

System Requirements: Internet Browser compatible with Java.

Implementation: Java Applet.

URL: http://advantageromania.com/cv/test.php

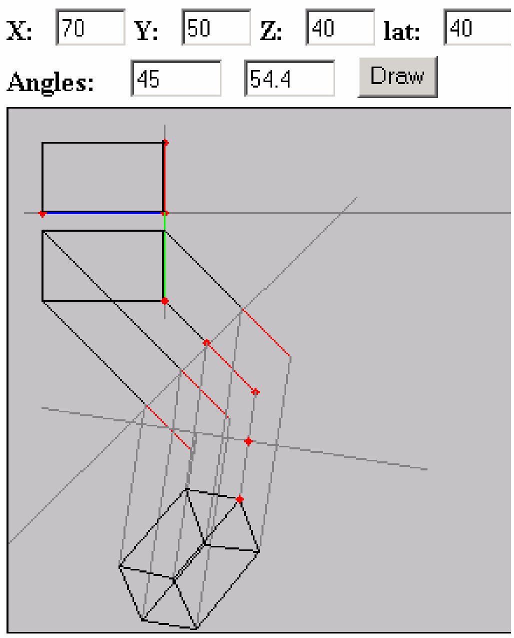

Fig. 5 Application program test.php

Some code from program are:

```
//draw rez rect
osg.setColor(Color.black);
        osg.drawLine(20+x+o+o1-o4-o6
,20+z+y+v+v1+v5+v6,20+x+okd+o1-od4-
od6,20+z+(y-l)+vkd+v1+vd5+vd6);
        osg.drawLine(20+x+o+o1-o4-o6
,20+z+y+v+v1+v5+v6,20+okb+o1-ob4-
ob6,20+z+y+vkb+v1+vb5+vb6);
        osg.drawLine(20+x+okd+o1-od4-
od6,20+z+(y-l)+vkd+v1+vd5+vd6,20+okc+o1-
oc4-oc6,20+z+(y-l)+vkc+v1+vc5+vc6 );
        osg.drawLine(20+okb+o1-ob4-
ob6,20+z+y+vkb+v1+vb5+vb6,20+okc+o1-oc4-
oc6,20+z+(y-l)+vkc+v1+vc5+vc6 );
        //draw z
        osg.drawLine(20+x+o+o1-o4-o6,
20+z+y+v+v1+v5+v6,20+x+o-oz4-o6
,20+z+y+v+vz5+v6);
        osg.drawLine(20+x+okd+o1-od4-
od6,20+z+(y-l)+vkd+v1+vd5+vd6,20+x+okd-
ozd4-od6,20+z+(y-l)+vkd+vzd5+vd6);
        osg.drawLine(20+okb+o1-ob4-
ob6,20+z+y+vkb+v1+vb5+vb6,20+okb-ozb4-
ob6,20+z+y+vkb+vzb5+vb6);
        osg.drawLine(20+okc+o1-oc4-oc6,20+z+(y-
l)+vkc+v1+vc5+vc6,20+okc-ozc4-oc6,20+z+(y-
l)+vkc+vzc5+vc6);
osg.setColor(Color.red);
        osg.fillOval(18+x+o+o1-o4,
18+z+y+v+v1+v5,5,5);
        osg.fillOval(18+x+o+o1-o4-o6
,18+z+y+v+v1+v5+v6,5,5);
        //osg.dispose();
g.drawImage(imgCanvas,0,0,this);
        g.setColor(Color.black);
       g.drawRect(0, 0, width-1, height-1);
        //g.fillArc(100,100,50,50,0,30);.......
```

4. CONCLUSION

The methods of axonometric representation of objects (parts), based on their orthogonal representation and using the transformation methods of projections presented in this paper are fast, accurate, easily accessible and have the advantage over traditional representations that they do not distort objects.

The computerized tracing program of the axonometric representation presented in the paper enables the interactive study by modifying descriptive coordinates of the points that define the object and the angle between axes.

REFERENCES

[1] *S., Ioniţă*, Geometrie Descriptivă. Notiuni teoretice si aplicatii, Ed. BREN, Bucureşti 2008, ISBN 978-973-648-809-2.

[2] *D., Marin*, Design industrial Designul formei, Editura BREN, ISBN 978-973-648-875-7, Bucuresti, 2011.

[3] *D., Marin*, Desen tehnic industrial, Editura BREN ,ISBN 978-973-648-633-3, Bucuresti, 2009.

[4] *D., Marin*,. Geometrie descriptiva, Editura BREN ,ISBN 973-648-192-1, Bucuresti, 2003.

[5] *I., Simion*, Grafica inginereasca, Editura PRINTECH, ISBN 973-652-403-5, Bucuresti, 2001.