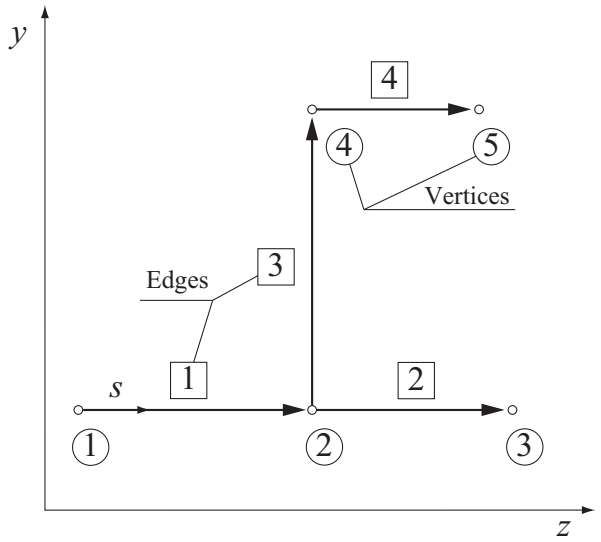
The SecPropGRAPH program

The SecPropGRAPH program computes the geometric properties of thin-walled open cross-sections. It was written and tested in MATLAB 7.3.0 (R2006b). The program is a function with the syntax:

```
Section = SecPropGRAPH(Vertices, Edges)
```

where:

Vertices – array containing the consecutive vertex numbers and their coordinates (y, z),
Edges – array containing the consecutive edge numbers and their thicknesses,
Section – output structure.



Rys. 1. Graph

Example script:

```
Vertices = [
   1  -0.04   0
   2  -0.03   0
   3  -0.02   0
  ...
  17  -0.02   0.1
];

Edges = [
   1    1    2   0.005
   2    2    3   0.005
   3    3    4   0.005
```

```
  ...
  16   16   17   0.005
];

Section = SecPropGRAPH(Vertices, Edges)
```

As a result, the program returns the Section structure:

```
          Area: 8.0000e-004
            Sy: 9.7409e-021
            Sz: -2.3293e-021
            So: 9.9262e-023
            Jy: 1.1487e-006
            Jz: 7.5446e-008
           Jyz: -1.4426e-021
            Jr: 1.2242e-006
            Jt: 6.6667e-009
            Jo: 7.0940e-011
           Jyo: -2.1403e-023
           Jzo: -9.9262e-023
           Jry: -5.9613e-009
           Jrz: 5.9252e-009
           Jro: -3.7094e-011
       UserYc: -0.0062
       UserZc: 0.0437
       UserYs: 0.0067
       UserZs: 0.0170
       UserYq: -0.0162
       UserZq: 6.9389e-018
           Ys: 0.0159
           Zs: -0.0252
           Yq: -0.0050
           Zq: -0.0446
        Gamma: -0.1116
    Transform: [2x2 double]
     Vertices: [17x4 double]
```

The following notation is used in the formulas below:

d – dendrite (tree-like graph) of the cross-section midline,

s – path parameter along the directed midline,

$t(s)$ – edge thickness,

$h(s)$ – edge length,

$\omega(s)$ – sectorial coordinate,

$y(s)$, $z(s)$ – parametric coordinates of the cross-section midline.

The output structure Section contains the following fields:

Area – cross-sectional area of the thin-walled profile,

$$A = \int_d t(s)\ \mathrm{d}s, \tag{1}$$

Sy – first moment of area about the y axis,

$$S_y = \int_d z(s) \cdot t(s)\ \mathrm{d}s, \tag{2}$$

Sz – first moment of area about the z axis,

$$S_z = \int_d y\left(s\right) \cdot t\left(s\right)\ \mathrm{d}s, \tag{3}$$

So – sectorial first moment of area,

$$S_\omega = \int_d \omega\left(s\right) \cdot t\left(s\right)\ \mathrm{d}s, \tag{4}$$

Jy – second moment of area about the y axis,

$$J_y = \int_d z^2\left(s\right) \cdot t\left(s\right)\ \mathrm{d}s, \tag{5}$$

Jz – second moment of area about the z axis,

$$J_z = \int_d y^2\left(s\right) \cdot t\left(s\right)\ \mathrm{d}s, \tag{6}$$

Jyz – product of inertia,

$$J_{yz} = \int_d y\left(s\right) \cdot z\left(s\right) \cdot t\left(s\right)\ \mathrm{d}s, \tag{7}$$

Jr – polar moment of inertia,

$$J_r = \int_d \left(y^2\left(s\right) + z^2\left(s\right)\right) \cdot t\left(s\right)\ \mathrm{d}s, \tag{8}$$

Jt – torsion constant,

$$J_t = \frac{1}{3}\sum_{i=1}^{n} t_i^3 \cdot h_i, \tag{9}$$

Jo – sectorial moment of inertia (warping constant),

$$J_\omega = \int_d \omega^2\left(s\right) \cdot t\left(s\right)\ \mathrm{d}s, \tag{10}$$

Jyo – sectorial product of inertia,

$$J_{y\omega} = \int_d y\left(s\right) \cdot \omega\left(s\right) \cdot t\left(s\right)\ \mathrm{d}s, \tag{11}$$

Jzo – sectorial product of inertia,

$$J_{z\omega} = \int_d z\left(s\right) \cdot \omega\left(s\right) \cdot t\left(s\right)\ \mathrm{d}s, \tag{12}$$

Jry – higher-order moment,

$$J_{ry} = \int_d \left(y^2\left(s\right) + z^2\left(s\right)\right) \cdot y\left(s\right) \cdot t\left(s\right)\ \mathrm{d}s, \tag{13}$$

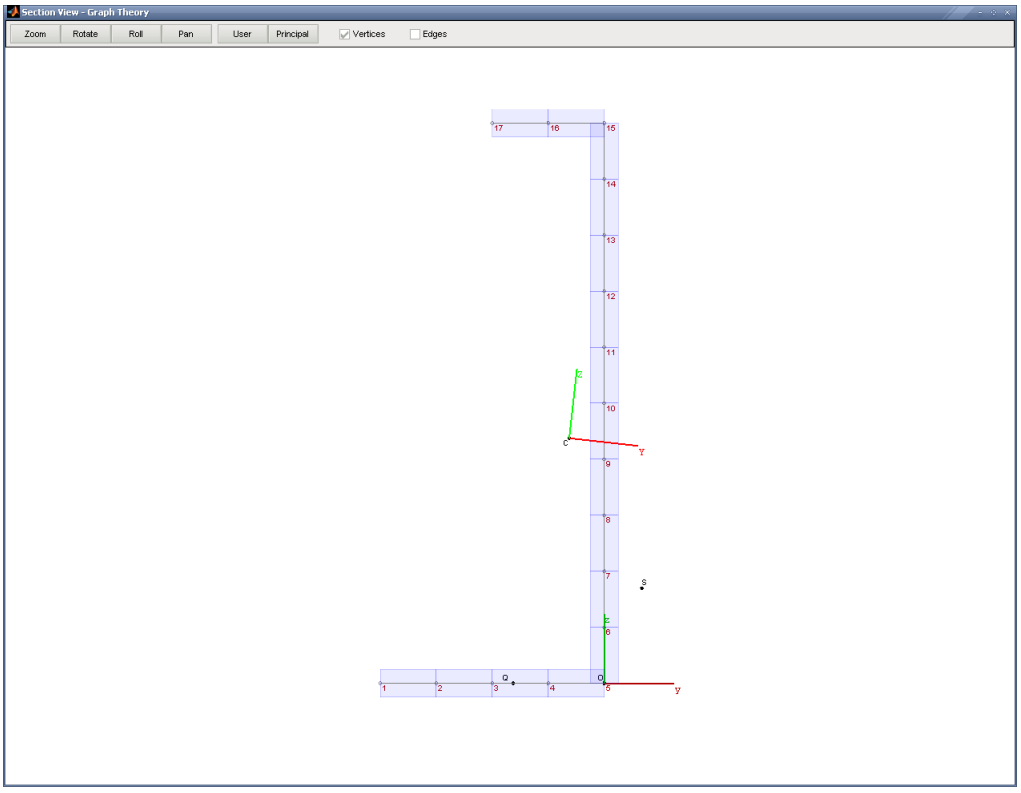
Jrz – higher-order moment,

$$J_{rz} = \int_d \left(y^2\left(s\right) + z^2\left(s\right)\right) \cdot z\left(s\right) \cdot t\left(s\right)\ \mathrm{d}s, \tag{14}$$

Jro – higher-order moment,

$$J_{r\omega} = \int_d \left(y^2(s) + z^2(s)\right) \cdot \omega(s) \cdot t(s)\ \mathrm{d}s, \tag{15}$$

UserYc, UserZc – coordinates (y_C, z_C) of the centroid in the user coordinate system,
UserYs, UserZs – coordinates (y_S, z_S) of the shear centre in the user coordinate system,
UserYq, UserZq – coordinates (y_Q, z_Q) of the principal point of zero sectorial coordinate in the user coordinate system,
Ys, Zs – coordinates (Y_S, Z_S) of the shear centre in the principal centroidal axes,
Yq, Zq – coordinates (Y_Q, Z_Q) of the principal point of zero sectorial coordinate in the principal centroidal axes,
Gamma – angle γ of the transformation from the local (user-defined) coordinate system to the principal centroidal axes,
Transform – transformation matrix from the local user coordinate system to the principal centroidal axes,
Vertices – vertex coordinates in the principal centroidal axes.



Rys. 2. The SecPropGRAPH program window

The top toolbar contains the following tools:

– zooming the section sketch in and out,
– free rotation of the sketch,
– rotation of the sketch in the screen plane,
– panning the sketch,

– view in the user coordinate system,

– view in the principal centroidal coordinate system,

– display of vertex numbers,

– display of edge numbers.