CROSS-SECTION PROPERTIES

Name of program: ***polygon*** **V 2.0**

This program determines for a polygonal section the center of gravity, area, moments of inertia and main moments of inertia including the angle of rotation of the main axes.
Furthermore the stresses of all input points may be calculated for any combination of N (**positive**, if acting as **tension** force), My and Mz. (figure **2**). N may be entered as acting in the center of gravity (**default**) or any point of your choice.
Besides, the intersections of the neutral axis ($\sigma = 0$) and the polygon shape as well as the inclination γ of this axis are indicated.

Go to page 1.1 and enter all points counterclockwise (points 7 – 10 in fig. **2**), missing areas have to be input clockwise (pts. 2 – 6). Make sure that the dimensions of the coordinates are consistent with the loads (e.g. **cm** and kN**cm** !). If all n points are entered, key in ***x*** in the next input-box for $y_{,n+1}$ (***x*** stands for the letter-key ***x*** here and in all following inputs for ***x*** !).
The program then offers the opportunity to change points, otherwise enter ***0*** in the "change-box". Besides, the areas of circles may be subtracted, as depicted in the example of figure **1**. To exit this part of input enter ***x*** or ***0***, if the next diameter is requested.
To end the program here if there are no loads to be examined, enter ***x*** if the program prompts for the input of ***N***.

Following now is the input of the loads in corresponding text-boxes, which results in the output of the stress values for the input points. Furthermore, a plot of the contour including the main axis for I1 and I2 as well as the neutral axis is provided on page 1.2, a list of all results on pages 1.3 and 1.4.

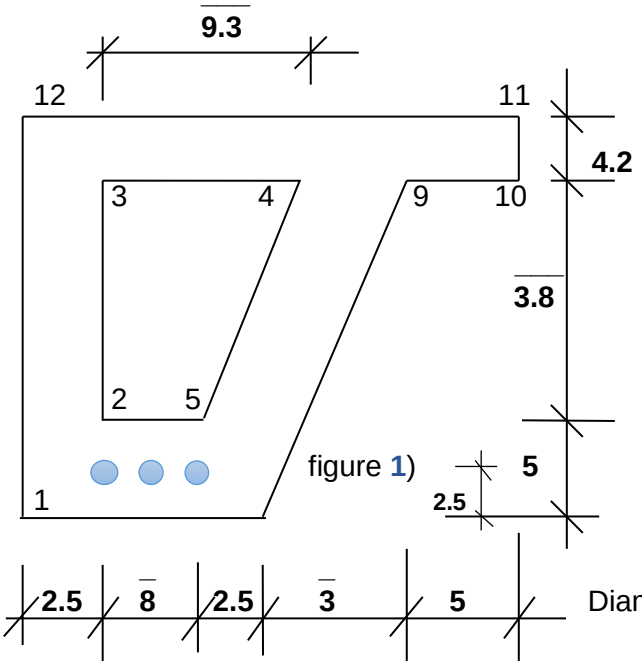


figure **1**)

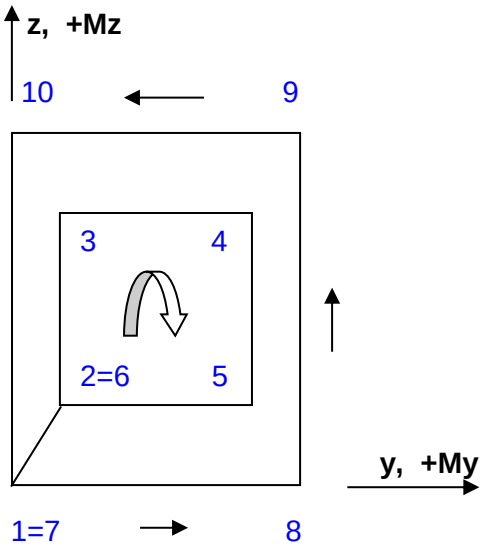


figure **2**)

Diameter of subtracted areas of circles: D = **3.0**

EXAMPLE

Being given the section of figure **1**) and the loads N = **- 50 kN** acting in the centre of the section; My = **-700 kNcm**, and Mz = **+200 kNcm**, calculate the stresses $\sigma_{,i}$ (1 <= i <=12). Three circle areas, each circle having the diameter D = **3** and the coordinates of the centre y_{c1} = **2.5**, y_{c2} = **6.5**, y_{c3} = **10.5** and z_c = **2.5** have to be subtracted.

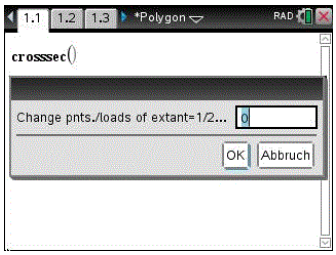
TABLE of COORDINATES ([cm]):

i	y_i	z_i	i	y_i	z_i
1	0	0	**7**	0	0
2	2.5	5	**8**	13	0
3	2.5	8.8	**9**	16	8.8
4	11.8	8.8	**10**	21	8.8
5	10.5	5	**11**	21	13
6	2.5	5	**12**	0	13

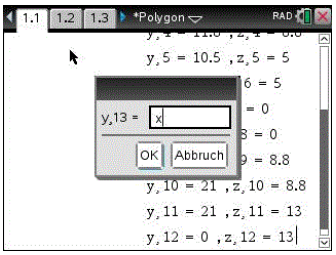
Store "**Polygon.tns**" into the MyLib-folder and start "**crosssec()**" on page 1.1 of the document. On the first request enter ***1*** if a section is already existing and points of the section have to be changed, or ***2***, if new loads are to be examined. Otherwise, as in this example, key in ***0*** (figure 3).

Now enter the points as indicated in the table. If the coordinate "**y-13 =** " is indicated, enter ***x*** to conclude this input (fig. 4). If you entered a wrong value for point i, enter now the number i in the "**Change point #i :** "-field and key in the new values, otherwise or to exit enter ***0***.

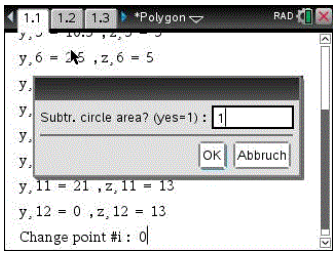
The program now prompts for the input of missing areas of circles on the cross section (fig.5):



3)



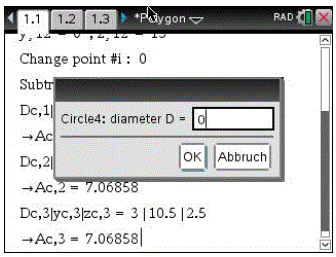
4)



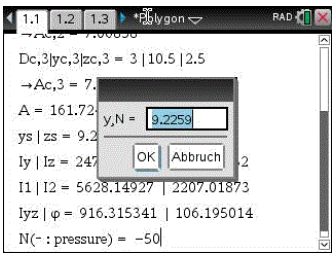
5)

Key in ***1***, then enter D, y_c and z_c for the three circles. After each input the subtracted area of this circle is depicted as $A_{c,i}$. Input ***0*** or ***x*** on the prompt of the fourth circle (fig. 6).

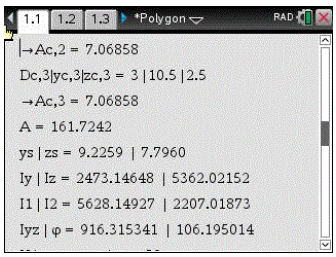
Now the section properties A, y_S | z_S, I_y | I_z, I_1 | I_2, I_{yz} | ϕ are calculated. Following then are the request-boxes for the loads. If N <> 0, the input of point ($y_{,N}$, $z_{,N}$), N is acting in, is requested additionally. Default are the coordinates of the centre of gravity (x_S,z_S).



6)



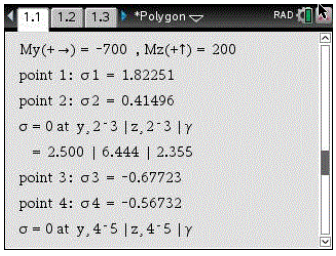
7)



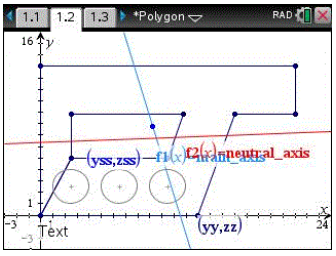
8)

Enter the **N** as given above and leave the indicated values of $y_{,N}$ and $z_{,N}$ in the screen (fig. 7), then key in the values of **My** and **Mz**.

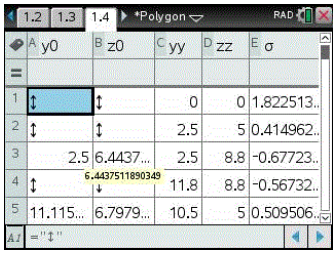
As result **A, y_S z_S I_y, I_z, I_{zy}, I_1, I_2** and the inclination ϕ of the main axis as well as all $\sigma_{,i}$ now are displayed (fig. 8 – 9) . If there is a change in sign from $\sigma_{,i}$ to $\sigma_{,i+1}$, an additional line depicts the



9)



10)



11)

values $y_{,i-(i+1)}$ and $z_{,i-(i+1)}$, where $\sigma = 0$,as demonstrated for points **2** and **3** in figure 9. γ stands for

the inclination of the neutral axis. The last display of the result summarizes the minimum/maximum stresses on the whole section.
For a new load case enter ***1*** on the next request , otherwise key in ***0*** to quit the program.

On page 1.2 of the document you will find a plot of the section with the main axis and additional the neutral axis γ, if you have entered loads (fig. **10**). Page 1.3 depicts again the section properties, while page 1.4 gives you the coordinates of the entered points (yy,zz), the intersection points (y0,z0) between contour and neutral axis and its inclination angle γ in [°] (fig. **11**). The intersection points $y0_{,i+1}$ and $z0_{,i+1}$ display the coordinates of a change of sign between $\sigma_{,i}$ and $\sigma_{,i+1}$, (σ=0), otherwise ↕ is indicated.

HINTS and WARNINGS

- Pay attention to the applied units! If you enter the coordinates in [**cm**] and moments in [**kNcm**], stresses are output in [**kN/cm²**] !
-The number of missing circle areas is unlimited for the calculation, whereas only the first **twelve** are indicated in the graph on page 1.2 !
-For the plot the scatterplot variables s1 and s2 are used. Do not delete them, in case it happens, go on page 1.3, press "**menu**" **3 – 4**, open the input line and enter {x← **yy**; y ← **zz** in s1 and {x ← **yss**; y ← **zss** for s2.

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