**PROPERTIES OF A POLYGONAL CROSS-SECTION**

*Name of program:* ***Polygon*** **v 1.3**

This program determines for a polygonal section the center of gravity (y**s**|z**s**), section area A, moments of inertia I**ys**, I**zs**, I**yz** and main moments of inertia I**1**, I**2** including the angle of rotation of the main axes **** and shows a plot of the entered cross-section including **** and (y**s**|z**s**).

Furthermore the stresses in all input points may be calculated for any combination of longitudinal force **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 the section area.

Besides, the intersection points of the neutral axis (**** = 0 ) with the contour as well as the inclination **** of this axis and its function term are indicated.

Start ***POLYGON***, select ***CrossSect*** 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

**EEX 8** or **EEX 9** in the next input-box for y**,n+1** to finish this entry.

Now any area of circles may be subtracted, as depicted in the example of figure **1**. To exit this part of input, enter ***0*** for the diameter, if the next diameter D,c is prompted.

To end the program here if there are no loads to be examined, leave ***0*** in the input fields for ***N***, ***My*** and ***Mz*** in the next screen.

To calculate stresses, enter now the loads in the corresponding fields. After the last entry the output of the stress values for the first points (~ 3 to ~5 ) is in the display. For an extensive output continue by pressing key “Enter”.

**\_\_\_**

**9.3** **z, +Mz**

12 11 10 9

**4.2**

3 4 9 10

3 4

2=6 5

**\_\_\_**

**3.8**

2=6 5

figure **1**) **5** figure **2**) **y, +My**

1=7 8 **2.5**

1=7 8

**\_ \_**

**2.5** **8** **2.5** **3** **5** 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 ******i**  (1 <= i <=12). Three circle areas, each circle defined by its 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 **yi** **zi**  i **yi** **zi**

**1** 0 0 **7** 0 0 **2** 2.5 5 **8** 13 0

**3** 2.5 8.8 **9** 16 8.8

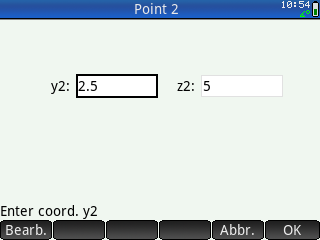
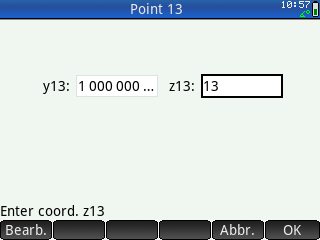
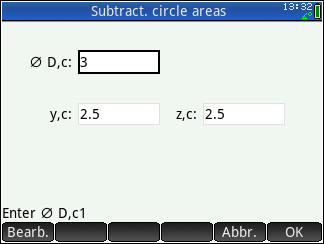
**4**  11.8 8.8 **10** 21 8.8

**5** 10.5 5 **11** 21 13

**6** 2.5 5 **12** 0 13

Start **POLYGON**, then select **CrossSect**.

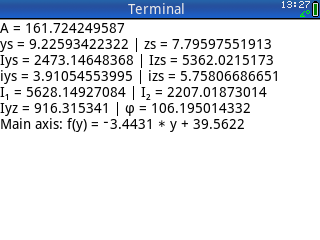
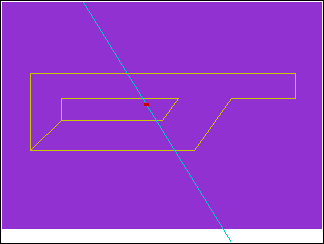
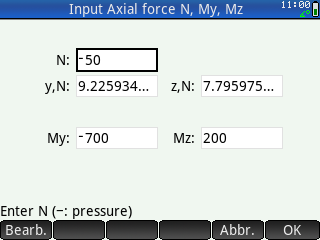
Now enter all points (fig. **3**) as indicated in the table. If the input-field of coordinate “**y-13 =** ” is depicted, enter **EEX 8** or **EEX 9**to conclude this input (fig. **4*)***. The program now prompts for the entry of missing areas of circles on the cross section (fig.**5**):

 **3**)  **4**)  **5**)

Key in the quantities of D, y**c** and z**c** for the three circles. Input ***0*** on the prompt of the fourth circle .

Now the section properties A, y**S** | z**S**, I**ys** | I**zs**, iys | izs, I**1** | I**2**, I**yz** | ****are calculated (fig. **6**) and displayed,****where :

**A:** section area, (**yS | zS**): centre of gravity, **Iys | Izs**: moments of inertia about y- | z-axis referred to the centre of gravity, **iys | izs**: radii of gyration, **I1 | I2**: principal moments of inertia, **Iyz**: moment of deviation, **** angle of the main axis [°]. Press “Enter” to get a plot depicting main axis and (y**s**|z**s**) (fig. **7**). Now call up the screen for the input of loads by pressing again the “Enter”-key. y,N and z,N define the target of N, with the centre of gravity (x**S**,z**S**) representing the default values.

 **6**)  **7**)  **8**)

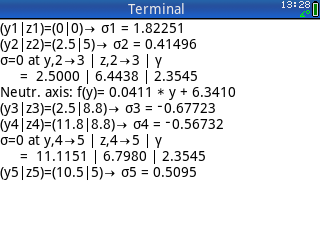
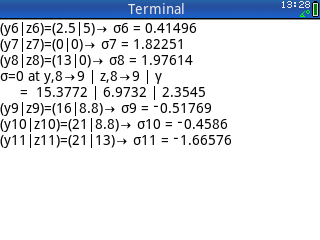
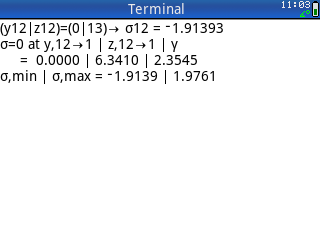
Enter -50 for **N** and leave the indicated values of y,**N** and z,**N** in the screen (fig. **8**), then key in the values of **My** ( = -700 ) and **Mz** ( = 200 ).

As result the stresses **,i** combined with the coordinates of each point (y**i** | z**i**) are now displayed

(fig. **9** – **10**) . If there is a change in sign from **,i** to **,i+1** , an additional line depicts the values

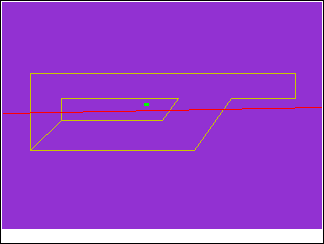
y,**i – (i+1)** and z, **i - (i+1)**, where ****= 0, as demonstrated for points **4** and **5** in fig. **9**), **8** and **9** (fig. **10**)

and **12** to **1** in fig. **11**). The quantity **** represents the inclination of the neutral axis [°].

 **9**)  **10**)  **11**)

The last line of the result summarizes the minimum/maximum stresses on the whole section.

(fig. **11**). Press “Enter” to see the location of the neutral axis referred to contour (fig.**12)**.

 fig.**12)**

**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**] !

- It is advised to define the cross-section in the first quadrant of the coordinate system.

- If you entered missing circle areas, they will not appear in the plot, cf. fig. **7**).

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