PLE-micro-CAD version 3.10.08

In the versions 3.10.02 up to 3.10.08 inclusive of PLE-micro-CAD a number of modifications and extensions of functionality have been realised. The modified modules are:

- K-module : the Kernel Module:
  - The assignment of the supports to the specified locations in DF2 has been improved. .
  - The application of (very) small radius bends has been restricted to the situation that more advanced options of the software are switched on.

- O-module : the Table support module:
  - The (iteration) behaviour of table supports has been improved

- J-module : the Articulated pipeline module:
  - The behaviour has been improved and the maximum number of joints increased.

- Q-module : the Geometrically non-linear cross-section behaviour Module:
  M-module : the Non-linear material behaviour Module:
  - The ovalisation range has been extended
  - The behaviour of small radius bends has been modeled more accurately.

- S-module : the Stress Module:
  - The iteration behaviour of the ADDCROS option has been improved.
  - The implosion check according to appendix D.3.3.4 of NEN 3650-2:2003 due to external pressure and/or bending moments has been extended.

The existing modules of version 3.10.01 have been modified / extended as follows.

SN014.1 *Function 2: Compose pipeline configuration*

- The new SUPPORT facility moved to this function has caused some problems unfortunately.
  If supports provided with a length and a support angle had been specified combined with branches (CONNECTS), an error could occur in the node numbering. This error has been corrected in version 3.10.07.
- The number of joints in the pipeline configuration was limited to about 200. For a long pipeline section with relatively short pipes (3 m for instance) this number is too small, so the maximum number of joints in a pipeline has been increased to 5000.

SN014.2 *Function 3.1: Compose pipe data model*

- For small radius bends a warning is given if BENDPAR is less than 0.2. This parameter λ is dependent on the diameter, wall thickness and bend radius.

$$\lambda = \frac{t\,R}{r^2\sqrt{1-\nu^2}}$$

t = wall thickness
R = bend radius
r = pipe radius (half of diameter)
ν = Poisson's ratio of bend material

This warning is a first indication of the bend behaviour. Other similar warnings may follow. See explanation sub Function 5.

SN014.3 *Function 5: Determine pipeline behaviour*

- If the bend parameter λ is less than 0.15 a warning is given. For $\lambda < 0.1$ the function process is stopped with an error unless the OVAL or MAT-NLN option has been selected (required module Q or Q and M). The first order bend behaviour modeling according to NEN 3650 and the second order approach according to Reissner (GENERAL analysis) both become too inaccurate for $\lambda < 0.1$. If the advanced OVAL or MAT-NLN option is switched on, the influence of higher harmonics is taken into account up to a limit value $\lambda = 0.01$. In the advanced options it is reckoned with that the diameter and the bend radius decrease due to ovalisation and bending moment.
- If the advanced OVAL or MAT-NLN option is switched on, the ovalisation of the cross-section is determined in this function as well. An error message was given when the ovalisation exceeded 25 % of the diameter. This error message has been changed to a warning, because of the possibility that the ovalisation should decrease drastically by applying horizontal soil support in design function 6.1.

SN014.4 *Function 6.1: Compose cross-section data model*

- If the ovalisation of an element of the pipeline exceeds 25% after redistribution and in spite of possible horizontal soil support, an error message is given. It's no use to make further calculations, because there is a great risk that the cross-section collapses.
- The iteration process of the ADDCROS mechanism has been improved again. In some cases this process runs with difficulty or comes not to an end possibly due to the presence of joints or table supports. A warning occurrs accordingly in the latter case.
- The error 'BENDPAR (λ) < 0.01' may also occur in this function due to possible additional loadings specified in tables SOILNB and TOPLOAD.
- An implosion check has been added according to appendix D.3.3.4 of NEN 3650-2 :2003 due to external pressure, bending moments and a combination. Because the formula for the allowable combination of external pressure and bending moment, if pressure is set to zero, is not compatible with the formula for an allowable bending moment only, the smallest value resulting from said formulae is assumed to be the allowable one. If this value is exceeded, a warning is given containing the amount of overrunning.