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Federal Department of Economic Affairs,
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State Secretariat for Economic Affairs SECO

District Heating Network Stress Analysis using PASS/START-PROF

Alex Matveev, START-PROF Product Manager

Leonid Korelstein, PASS VP on R&D and World market



About PASS Software

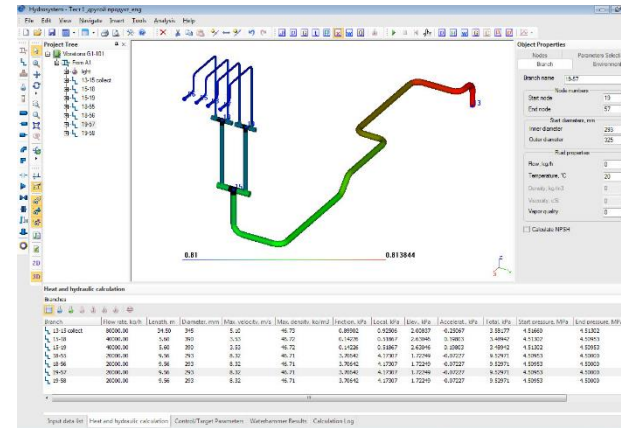
PASS Suite: all main aspects of piping and equipment analysis including:

- Piping systems fluid flow and heat exchange analysis & sizing
- Piping systems stress, fatigue, and stability analysis & sizing
- Equipment stress analysis for vessels, columns, tanks, and heat exchangers
- Nozzle-Shell Junction stress and flexibility analysis
- + **integration tools** with different **CAD systems**

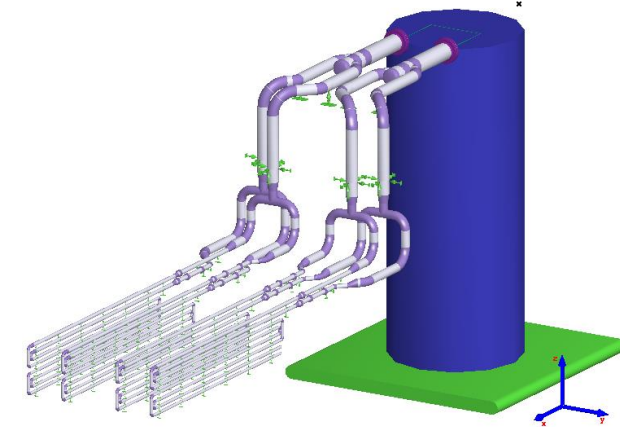
60+ years of non-stop development!



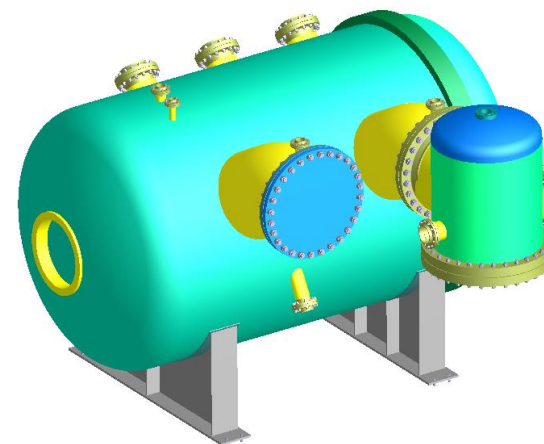
PASS/HYDROSYSTEM



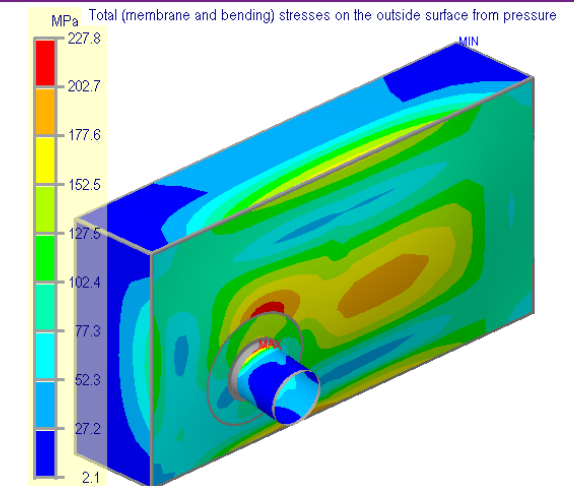
PASS/START-PROF



PASS/EQUIP



PASS/NOZZLE-FEM

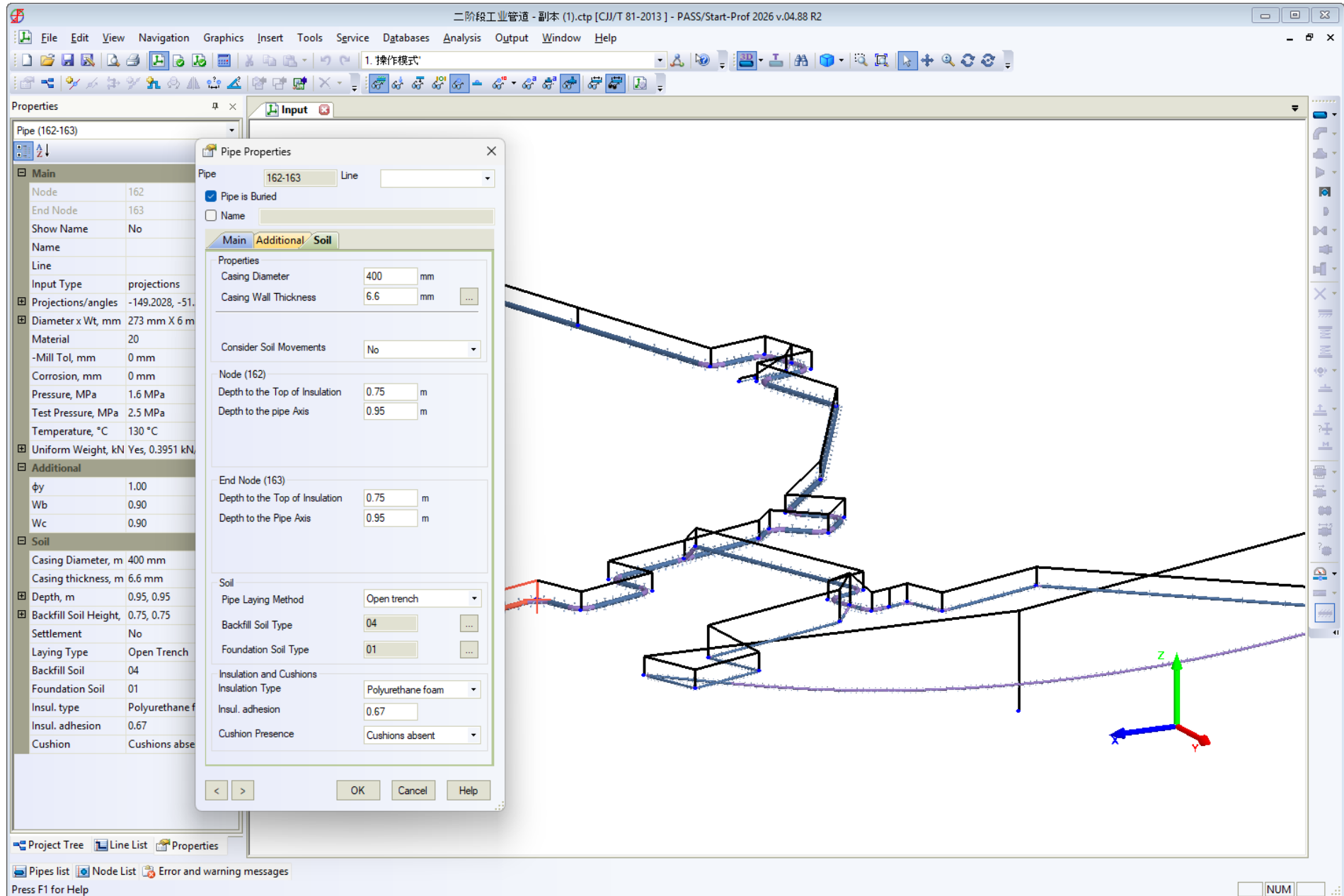


Widely Used

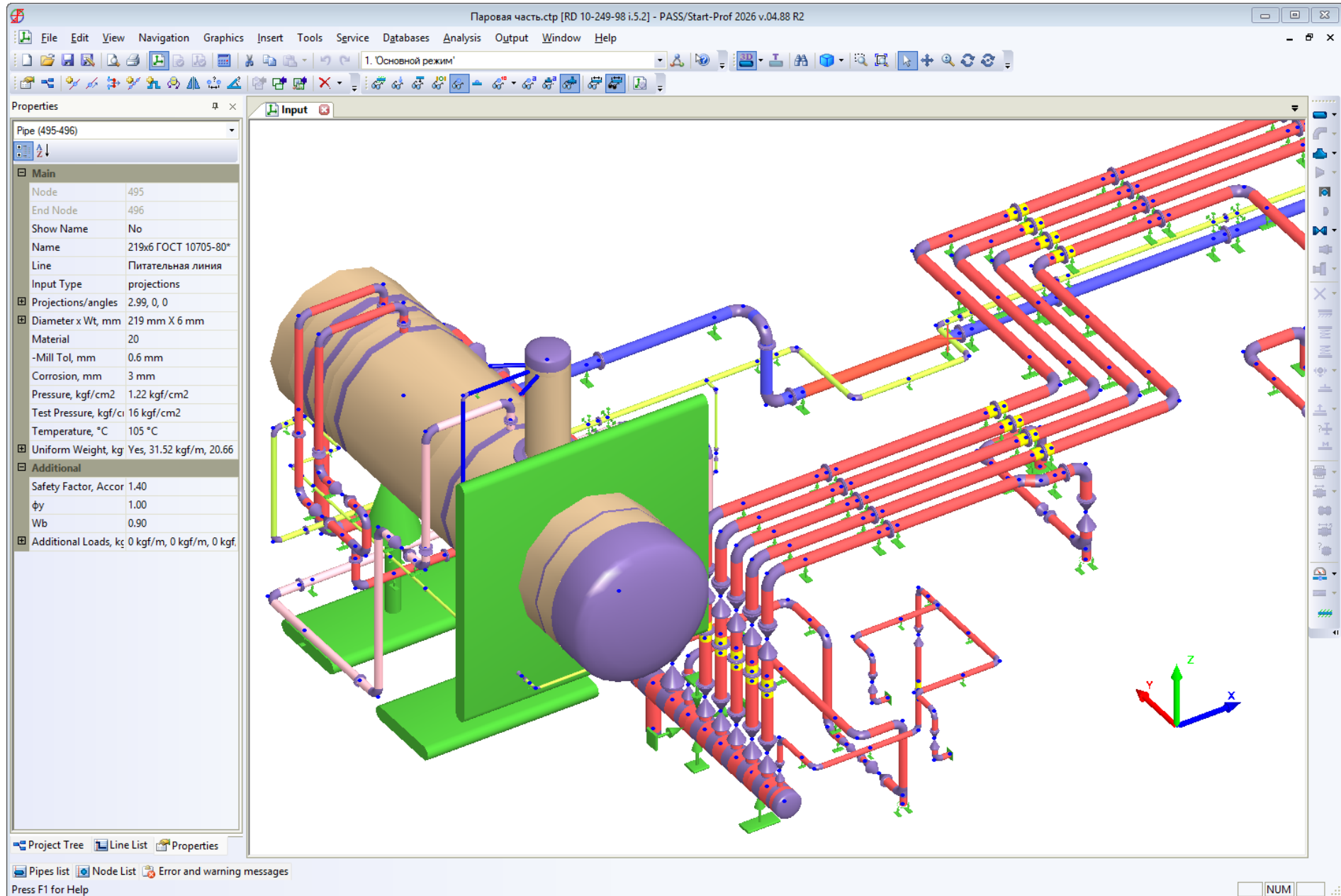
- Process Plant piping & utilities
- District Heating transfer piping & equipment
- Oil & Gas gathering, distribution, and storage piping networks and equipment
- Mechanical and in-house piping
- Pressure vessels, heat exchangers, columns, tanks and nozzles



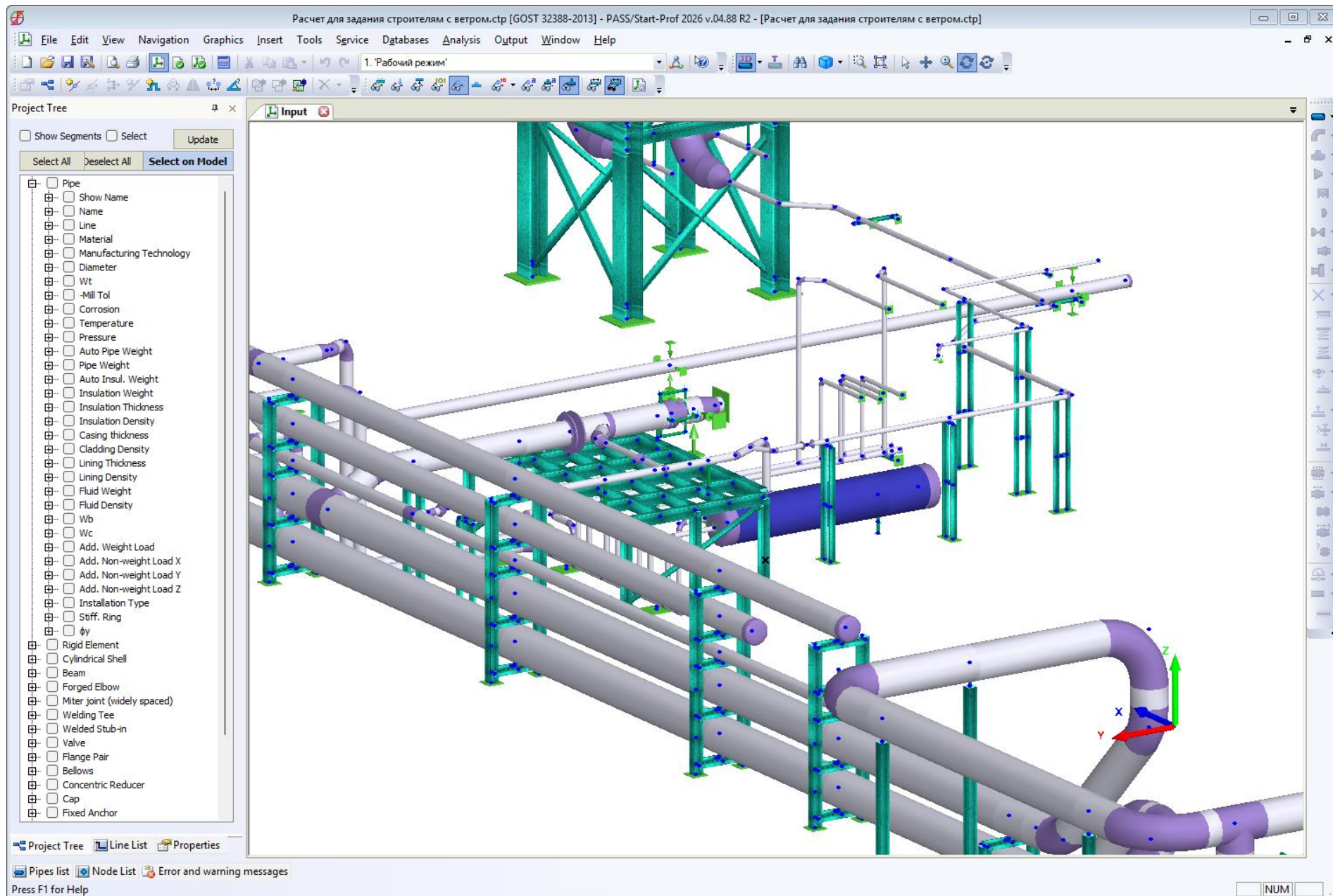
District Heating Network



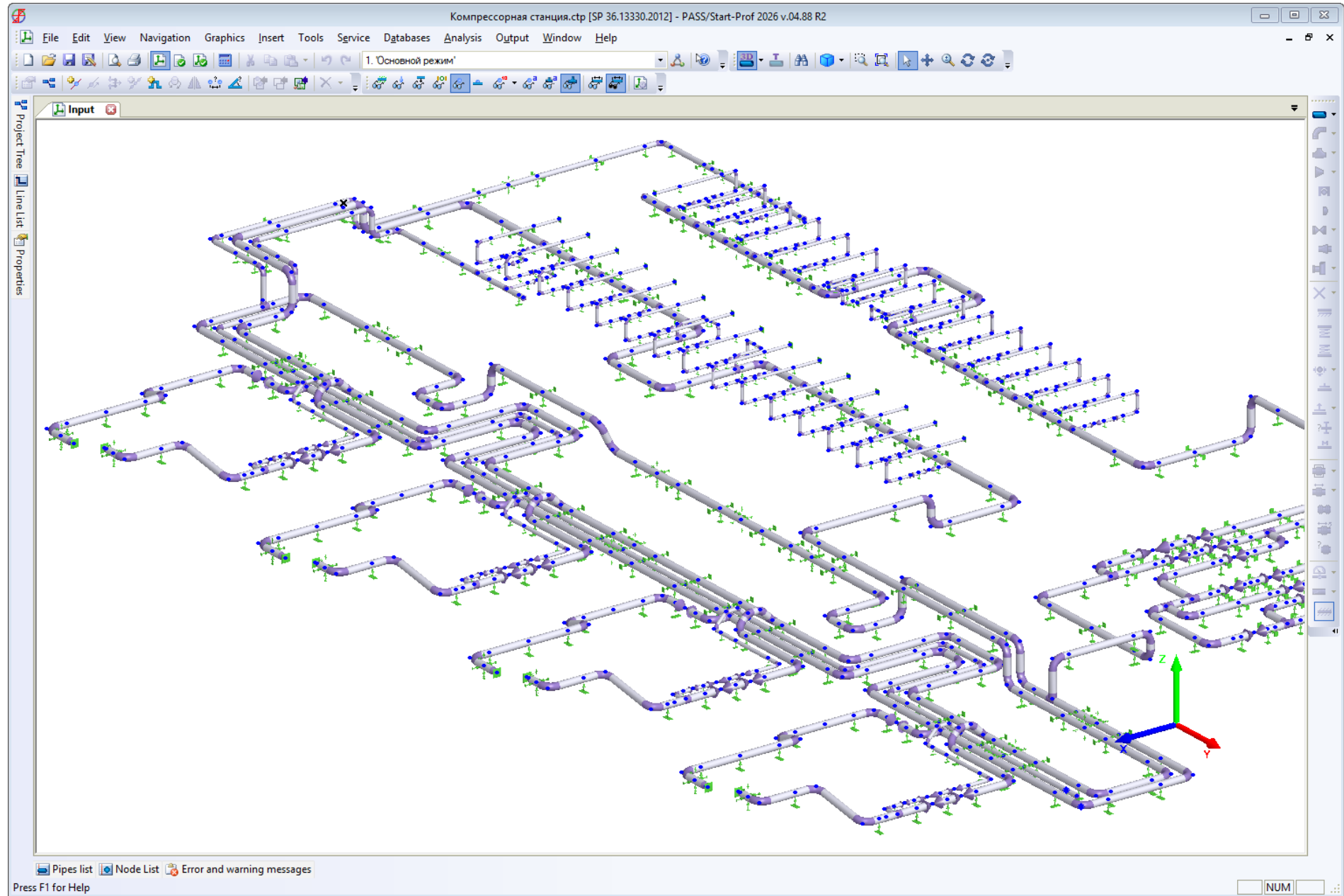
Power Piping



Process Piping



Gas Compressor Station



Tools for every Piping and Equipment Designer

Reduce Analysis Time, Effort & Cost

- Intelligent easy to use GUI interface with 3D model representation
- Integration with popular MCAD/CAD software
- New users does not need extensive training and can perform piping and equipment analysis in days rather than months
- An excellent tool for making professional piping and equipment engineers efficient

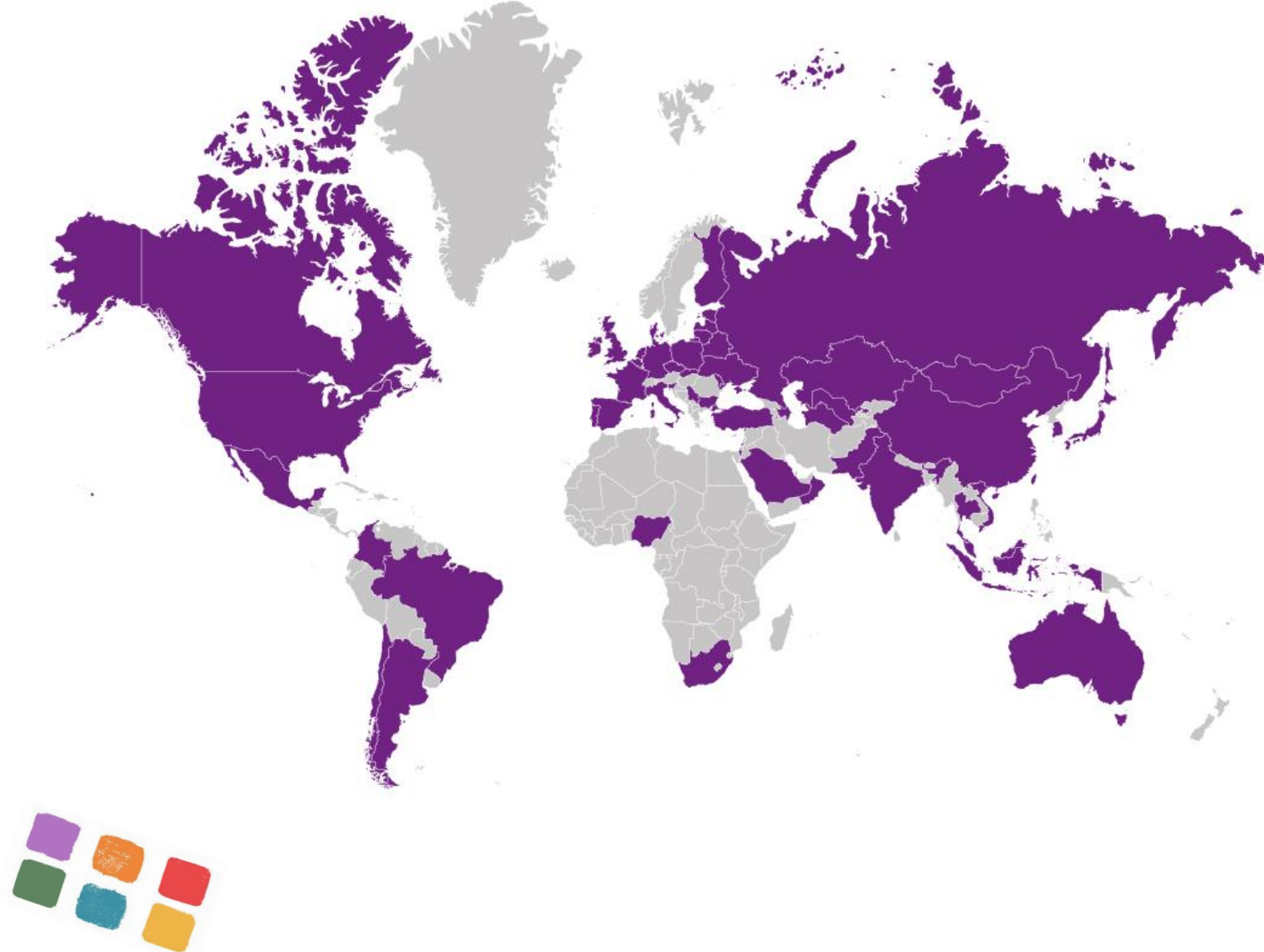


Embedded Intelligence

- Uses the most advanced models/algorithms and libraries
- Detailed help system with embedded intelligence from generations of piping and equipment design experts
- Online and offline professional trainings how to design and simulate your piping and equipment, step by step with interactive tools



PASS Geography



50+ countries

3 000+ customers

25 Partners Worldwide

Piping codes: 32

Wind, Seismic, Snow,
Ice codes: 18

PASS/START-PROF | Piping Systems Supported

- Above-ground Piping
- Piping on Steel constructions
- Buried Pipelines
- PUR Insulation Stress Check
- Vacuum Piping
- Jacketed Piping
- Cryogenic Low Temperature Piping
- High Pressure Piping
- High Temperature Piping with Creep and Stress Relaxation Effects
- Plastic Piping
- FRP, GRP Piping
- Nonferrous Material Piping



PASS/START-PROF Water Hammer

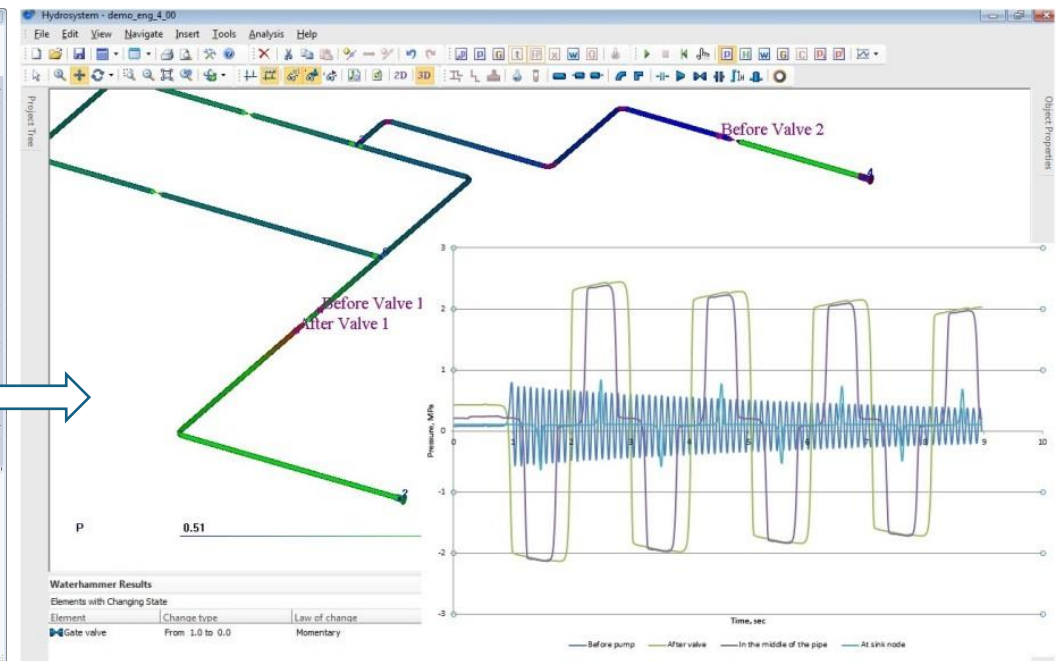
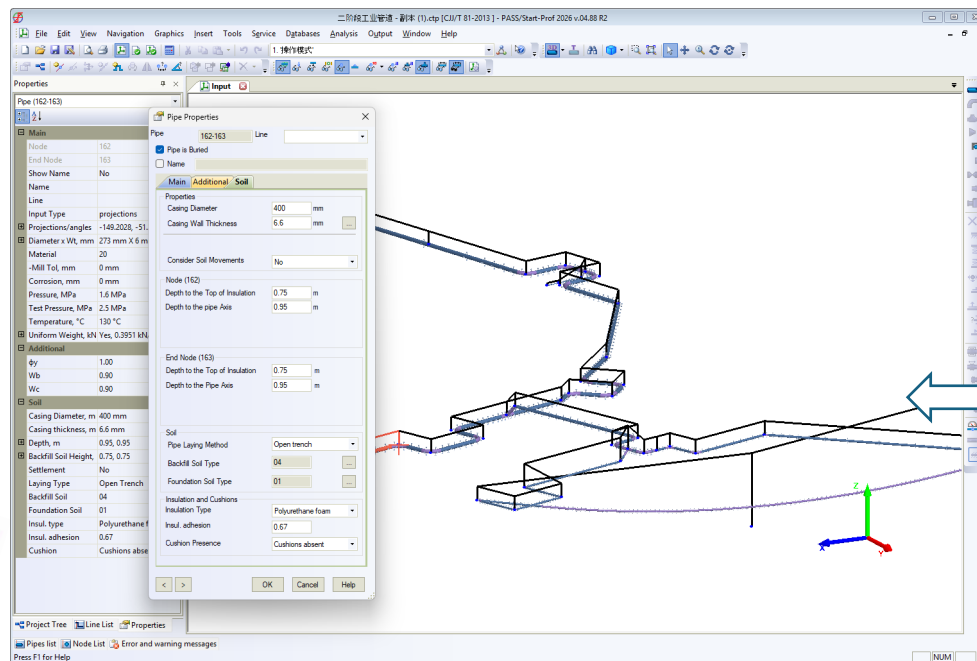
PASS/HYDROSYSTEM software allows to calculate the **water hammer loads** on the piping system and automatically transfer it into PASS/START-PROF 3D model. Detailed videos are available on PASS YouTube channel www.youtube.com/passuite, youtu.be/-ycRP_KEr8c, youtu.be/DbuKhdWY-tU



Pipe Stress Analysis Software

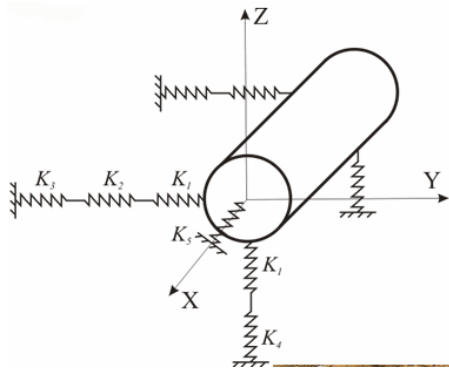


Fluid Flow Analysis Software



PASS/START-PROF | District Heating

PASS/START-PROF is de-facto **Industry Standard for District Heating Network Analysis** in China and post-Soviet countries. More than 800 District Heating Companies are Active Users



PASS/START-PROF District Heating History

- Since 1930 above ground district heating networks and power piping analysis
- Since 1994 the buried district heating networks in polyurethane insulation analysis
- Today, PASS and START-PROF have become the de facto standard for the design of district heating networks in post-Soviet countries
- Since 2015, the PASS/START-PROF software has gained popularity in China for district heating and has now become the de facto standard



PASS/Start-Prof | Supported Codes

Wide regulatory coverage

PASS/START-PROF can analyze piping according to 32 global codes, including the most recent and relevant district heating and power piping standards:

EU: EN 13941, EN 13480

Russia: GOST 55596, RD 10-400-01, RD 10-249-98,
GOST 33962-2016, 33963-2016, 33964-2016,
33965-2016

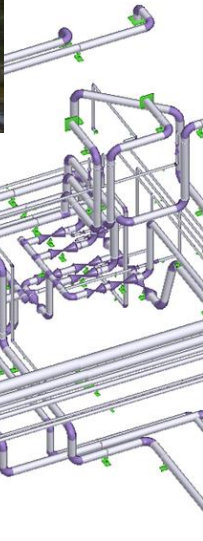
China: CJJ/T 81-2013, GB/T 32270-2015

USA: ASME B31.1

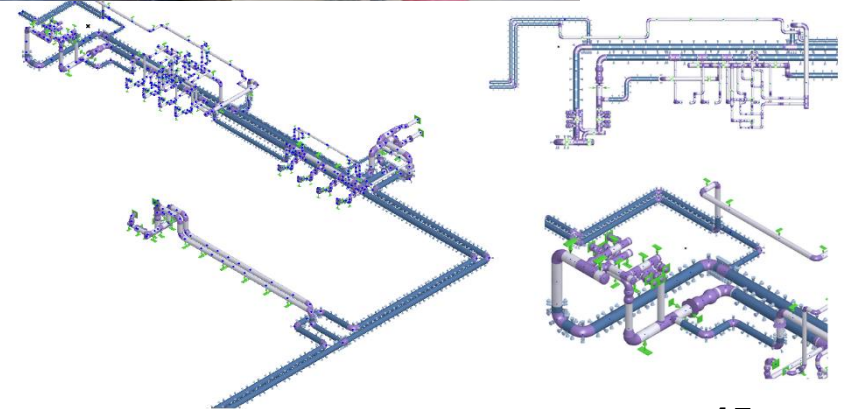


PASS/START-PROF | Examples from users

OilGasProject: Crude gas
booster compressor station



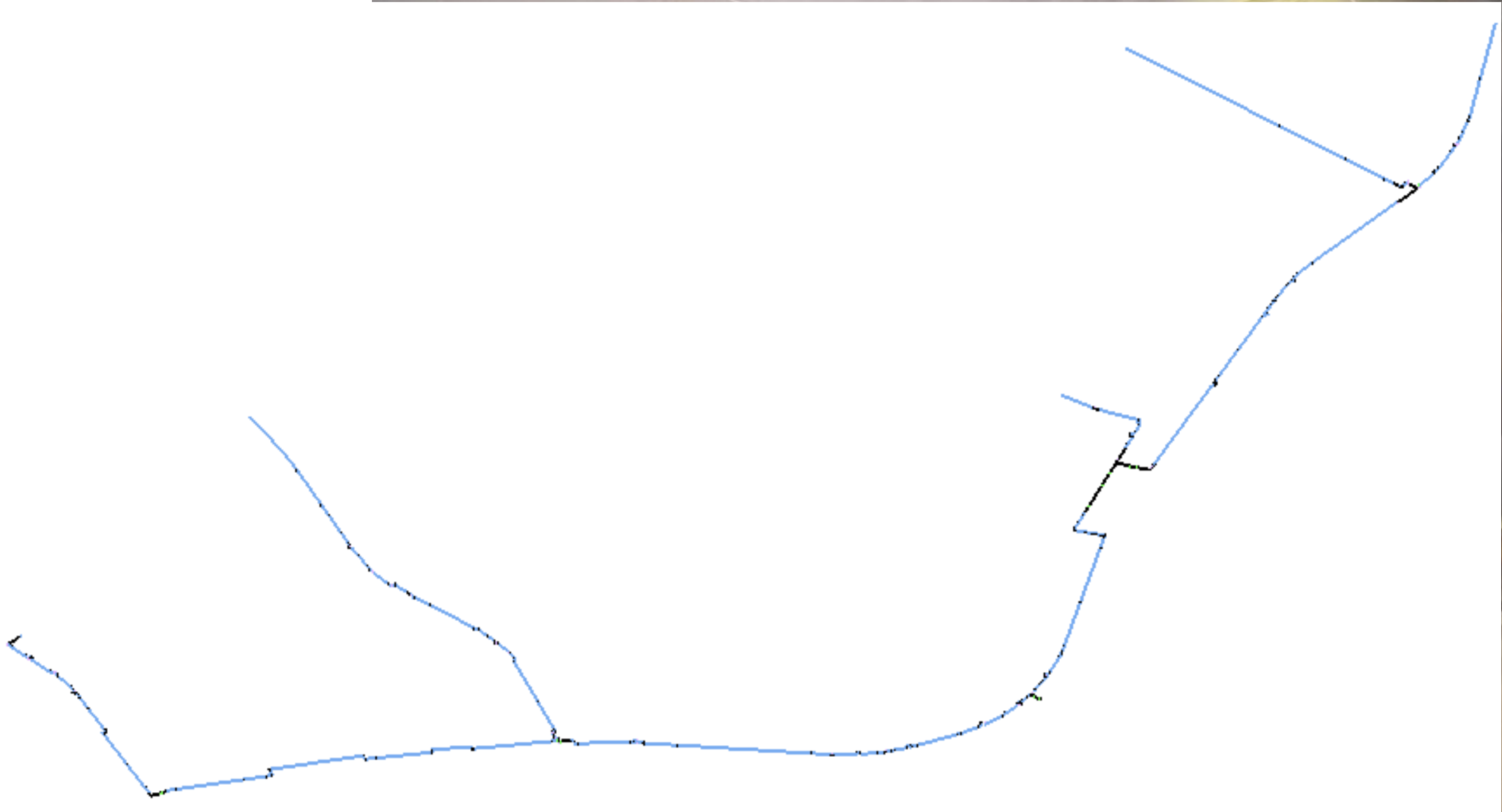
PowerChina Hebei Electric Power
Engineering: GUOHUA POWER
Dingzhou Power plant
Reconstruction Project





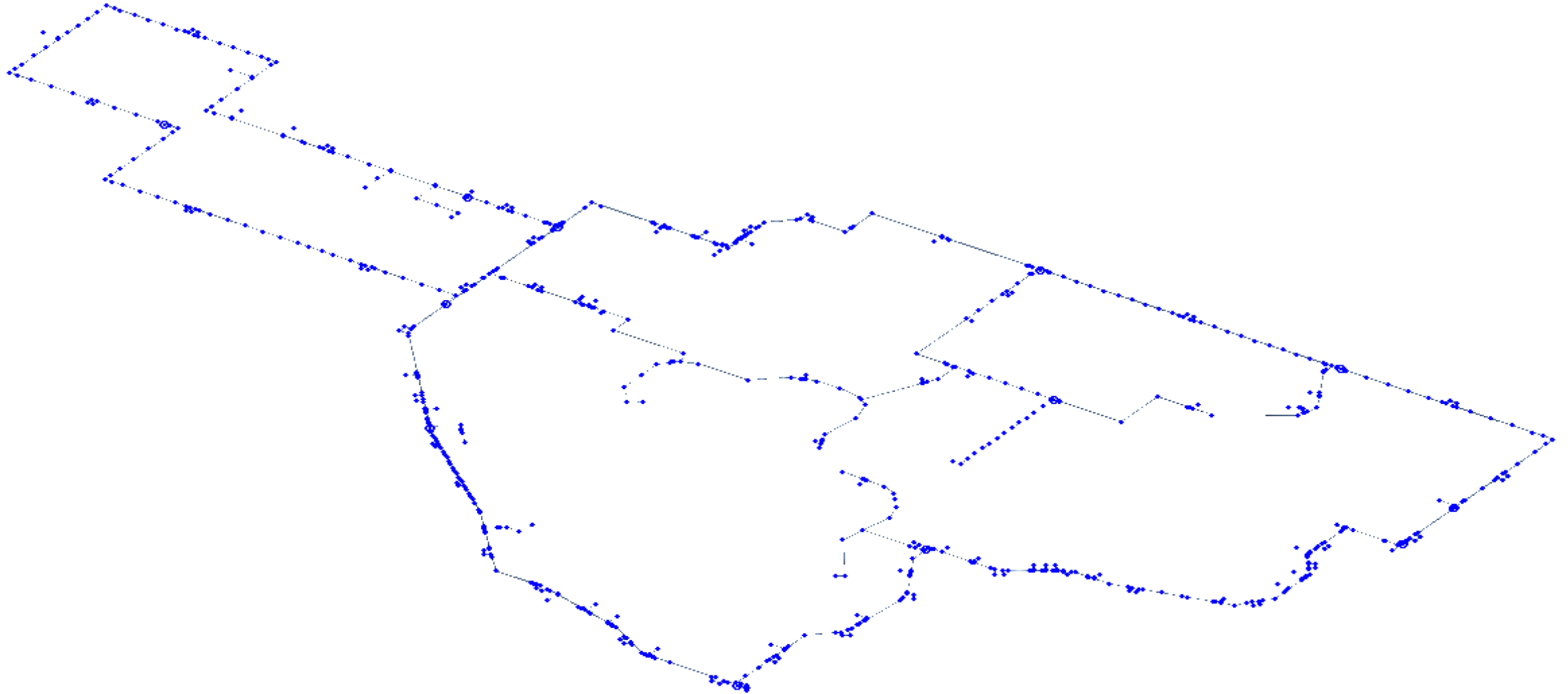
距离 3

距离 3

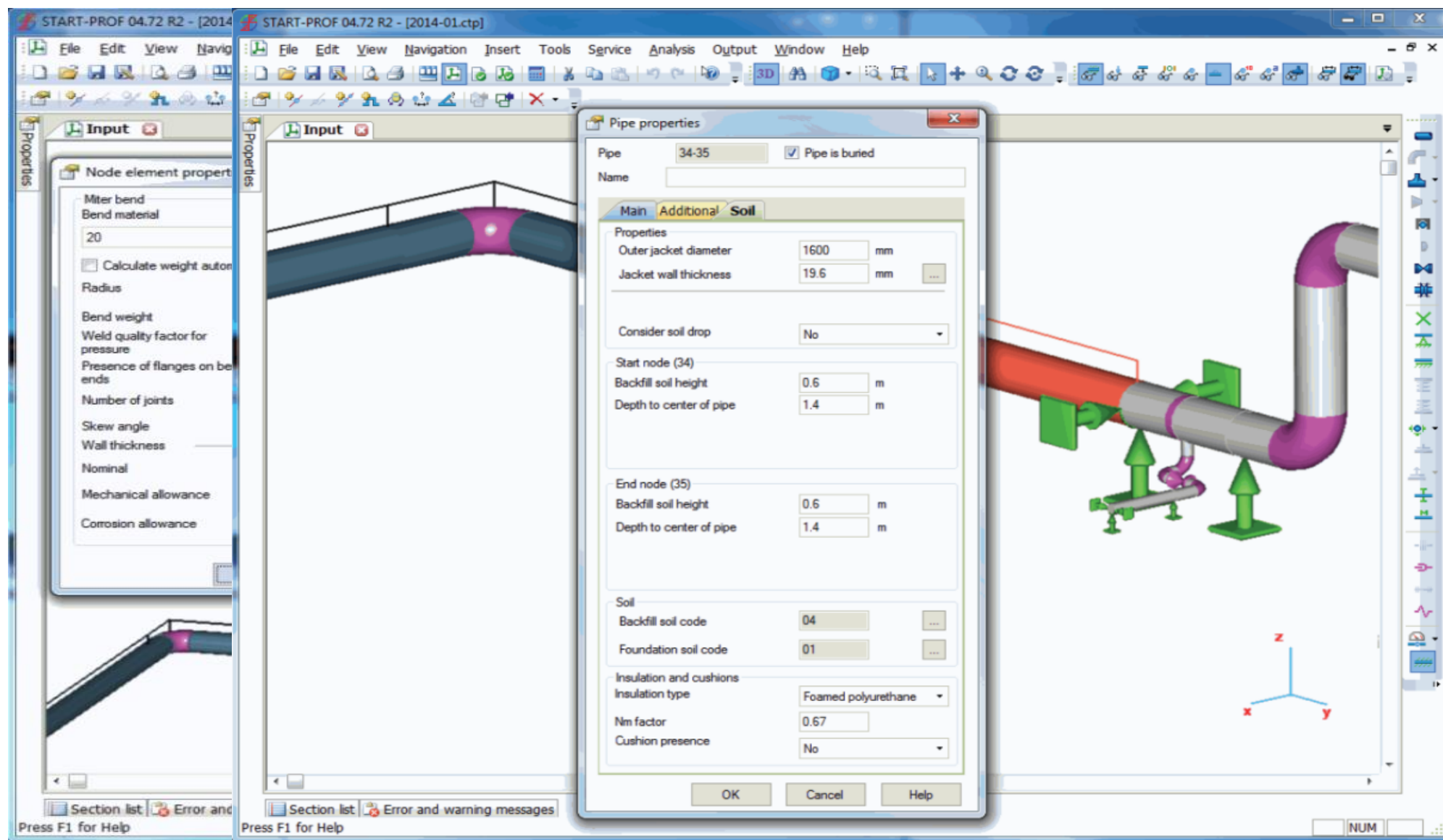


PASS/Start-Prof | Application Examples

Beijing Universal Amusement Park Buried District Heating Network Project in PASS/START-PROF

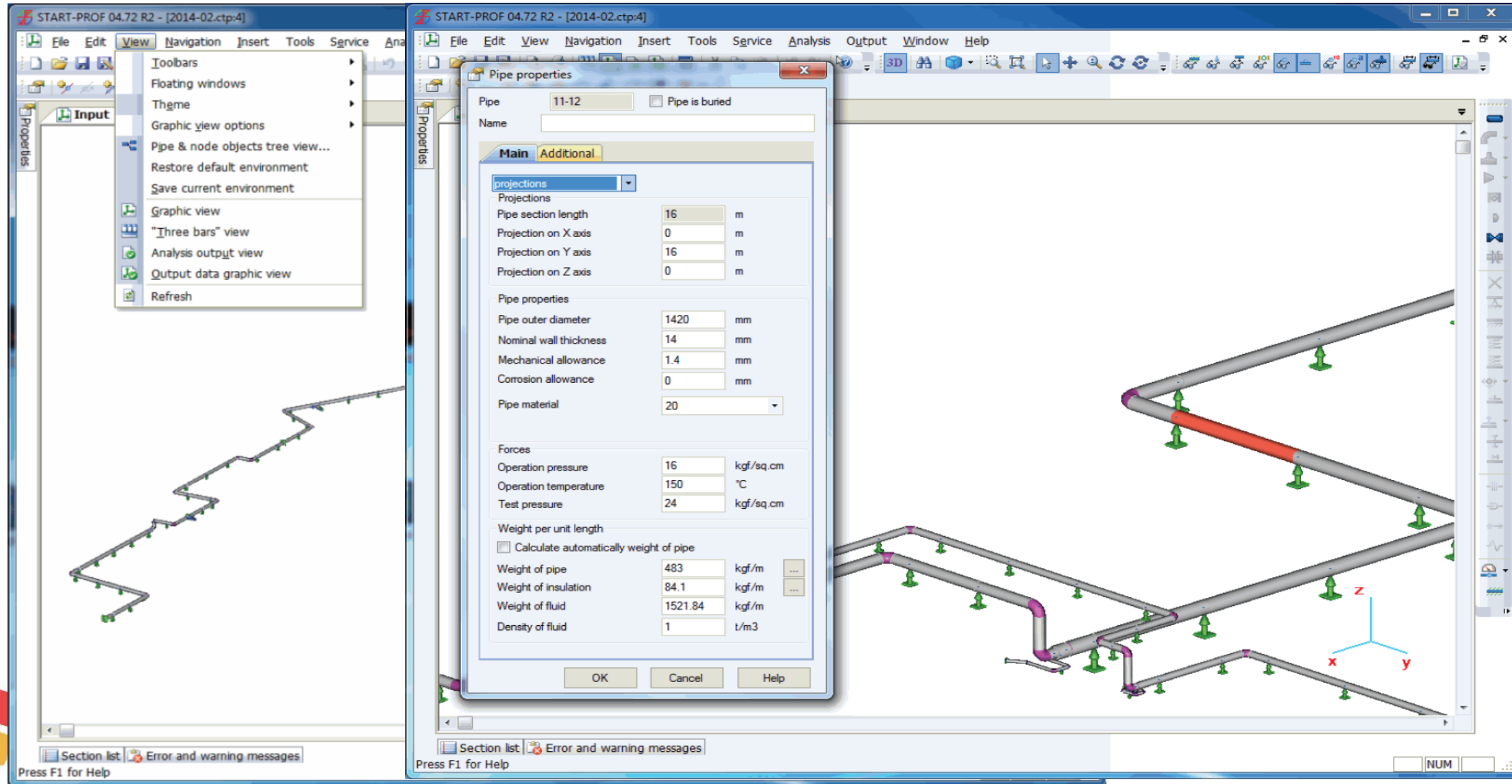


Some completed design projects from one of our 1400 users: OAO "Mosinjproject", Moscow, Russia.
Buried district heating network with polyurethane foam insulation built in Moscow. Depth 1.4 m, soil: sand, diameter 1420 mm, wall thickness 14 mm, Pressure 1.6 MPa, Temperature 130°C



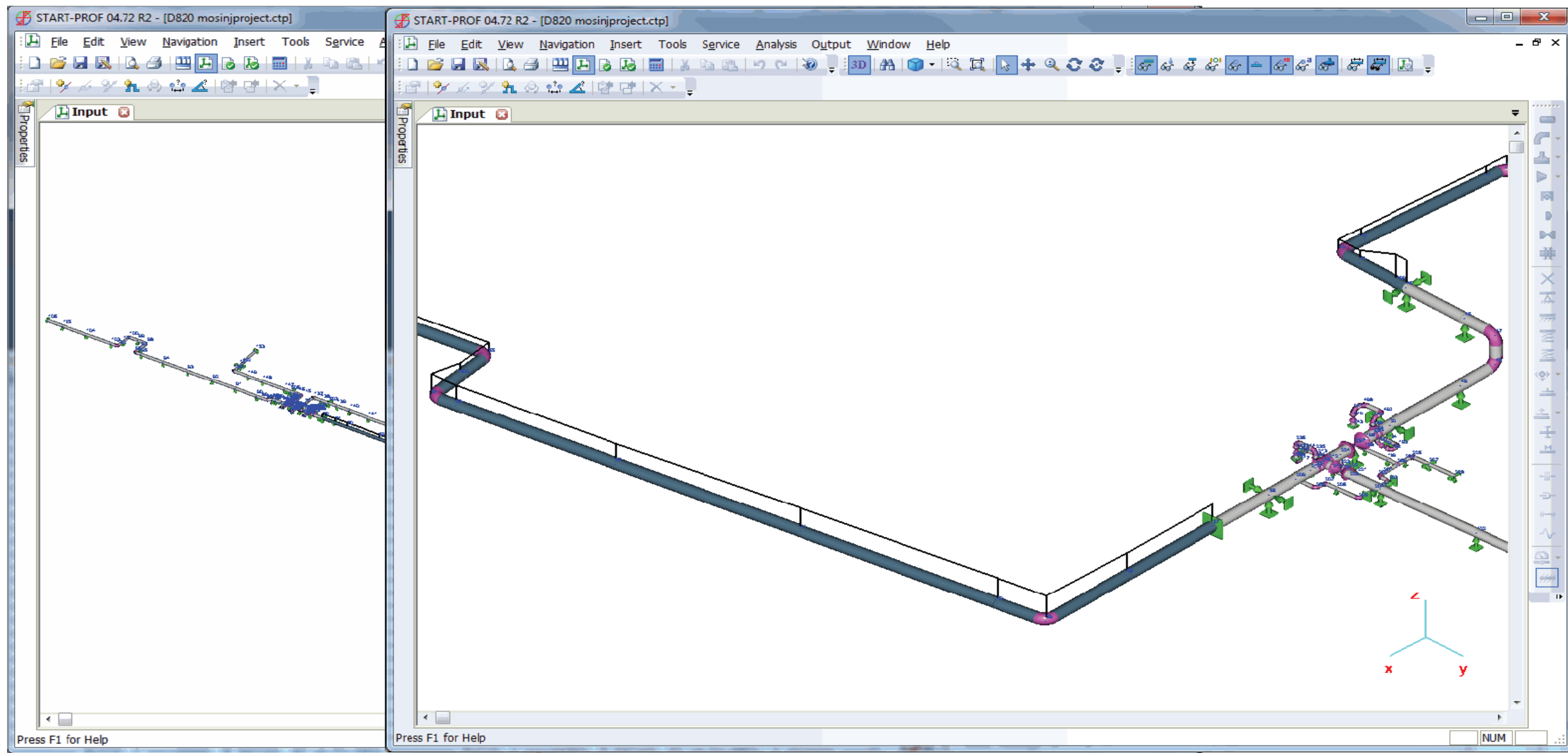
OA0 "Mosinjproject", Moscow, Russia.

Above ground district heating network with polyurethane foam insulation built in Moscow. Diameter 1420 mm, wall thickness 14 mm, Pressure 1.6 MPa, Temperature 150°C



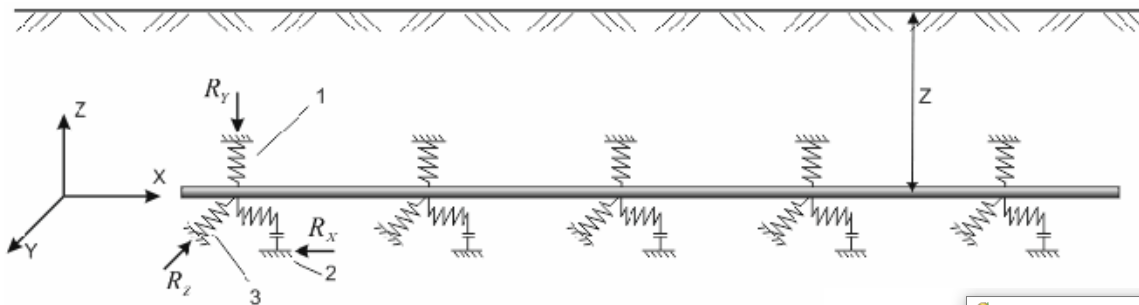
ОАО "Mosinjproject", Moscow, Russia.

Buried district heating network with polyurethane foam insulation at Moscow. Depth 2 m, soil: sand, diameter 820 mm, wall thickness 9 mm, Pressure 1.6 MPa, Temperature 130°C



PASS/Start-Prof | Pipe-soil interaction model

The main goal of dry soil model is to save on the number of supports in whole model to increase analysis speed without loss of result accuracy



- 1 - Vertical soil flexibility
- 2 - Longitudinal soil flexibility
- 3 - Horizontal soil flexibility



Pipe Properties

Pipe: 2.3 ☒ Pipe is Buried

Name:

Main Additional Soil

Properties

Insulation diameter: 500 mm

Submerged Pipe: No

Consider Soil Movements: No

Start Node (2)

Depth to the Top of Insulation: 2.485 m

Depth to the pipe Axis: 2.75 m

End Node (3)

Depth to the Top of Insulation: 1.175 m

Depth to the pipe Axis: 1.44 m

Soil

Pipe Laying Method: Open trench

Backfill Soil Type: 03

Foundation Soil Type: 01

Insulation and Cushions

Insulation Type: Other

Factor for Friction Angle: 1

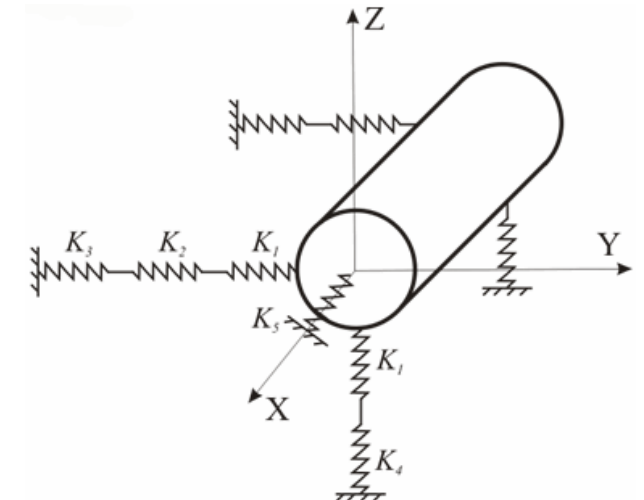
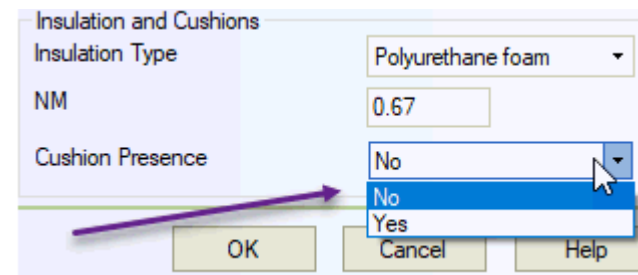
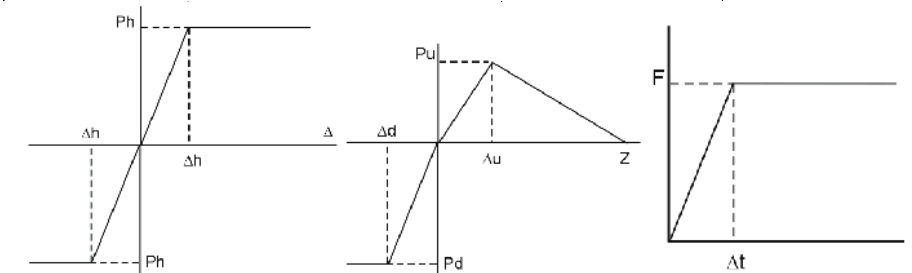
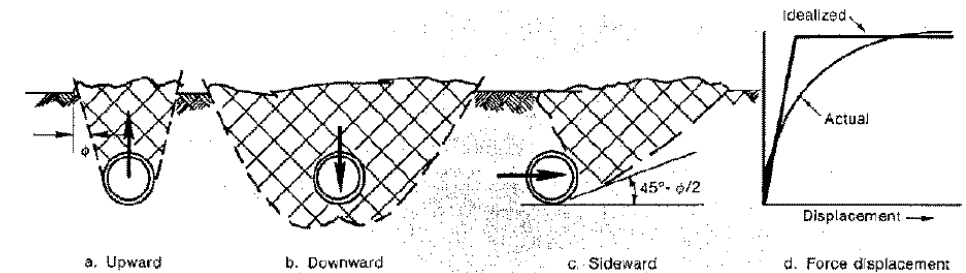
OK Cancel Help



PASS/Start-Prof | Pipe-soil interaction model

Each soil support stiffness consist of vertical, horizontal and longitudinal nonlinear springs

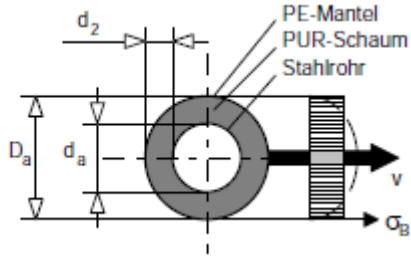
- Horizontal spring consist of 3 springs K_1 , K_2 , K_3 .
- Vertical Spring consist of 2 (or 3) springs K_1 , K_4 (and K_2).
- Longitudinal spring K_5



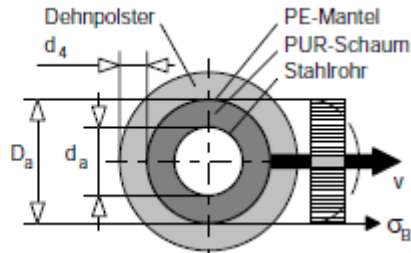
PASS/Start-Prof | Soil Model

Expansion cushion (pad) and polyurethane insulation flexibility

Faktor	Ersatzwert
B_1	1016.2
B_2	-4.0397
B_3	83.339
B_4	-1.1678
B_5	-0.56135
$E_{s,Grenz}$	8.8 N/mm ²



Faktor	steif
B_1	1.5026E-06
B_2	16.347
B_3	0.1242
B_4	1.286



- Key
- 1 cushion
 - 2 casing
 - 3 PUR
 - 4 steel
 - 5 soil

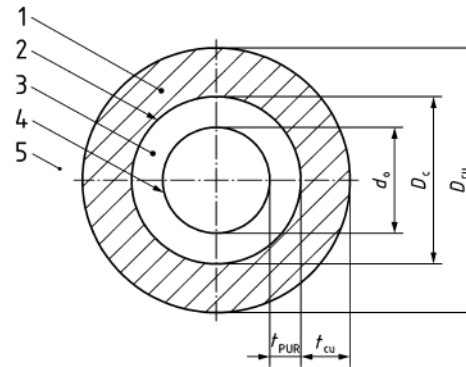
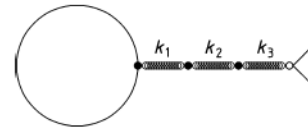


Figure 13 — Symbols for bedding constants



- Key
- k_1 line bedding constant for PUR
 - k_2 line bedding constant for expansion cushion
 - k_3 line bedding constant for surrounding soil

Figure 14 — Combined soil spring constant

Pipe Properties

Pipe: 15-16 ☒ Pipe is Buried

Name:

Main Additional **Soil**

Properties

Outer Casing Diameter: 1200 mm

Casing Wall Thickness: 14.9 mm

Consider Soil Movements: No

Start Node (15)

Depth to the Top of Insulation: 1.9 m

Depth to the pipe Axis: 2.5 m

End Node (16)

Depth to the Top of Insulation: 1.9 m

Depth to the Pipe Axis: 2.5 m

Soil

Pipe Laying Method: Open trench

Backfill Soil Type: 04

Foundation Soil Type: 01

Insulation and Cushions

Insulation Type: Polyurethane foam

NM: 0.67

Cushion Presence: No

OK Cancel Help

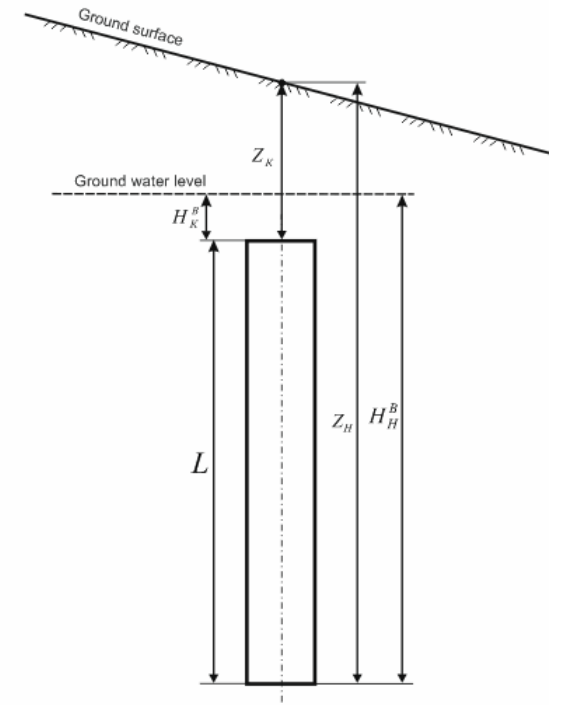
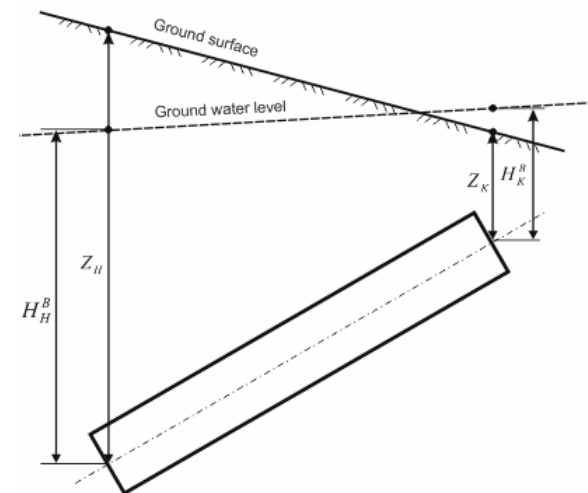
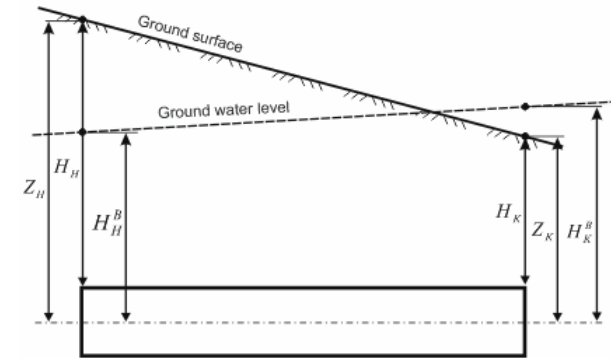
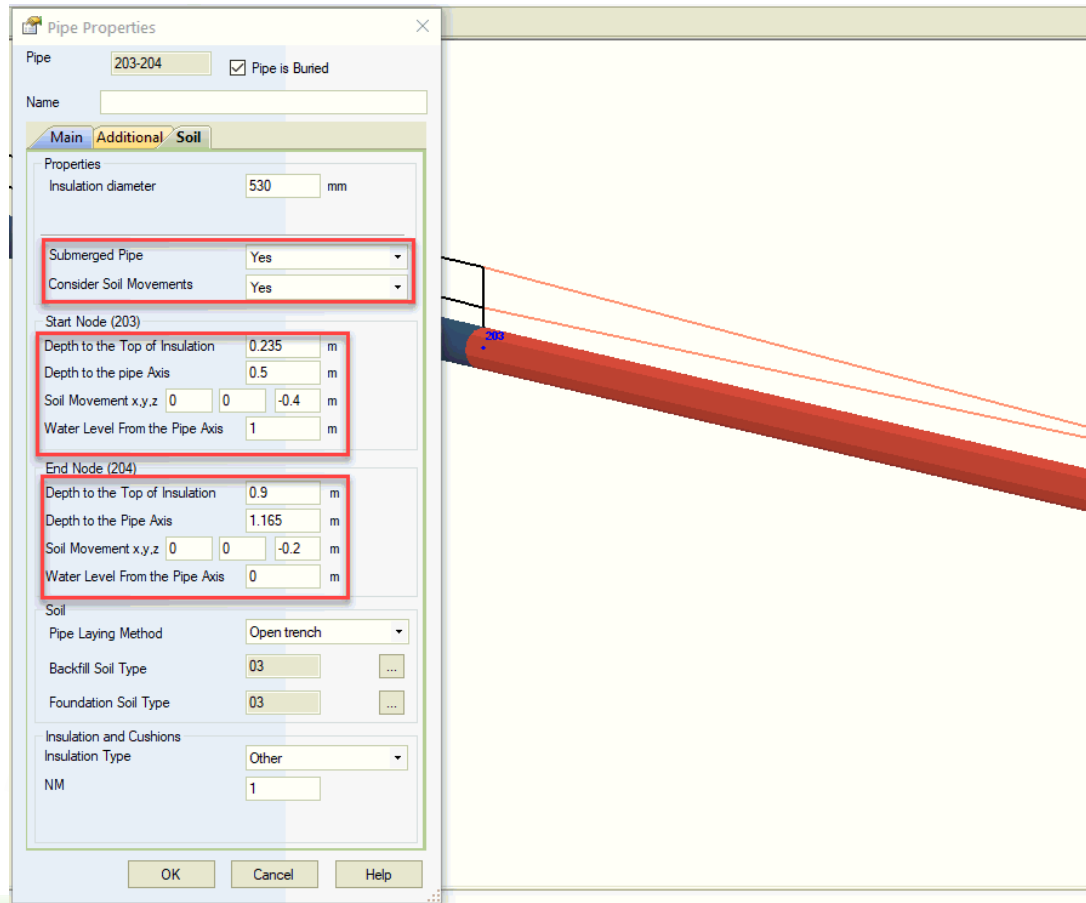


PASS/Start-Prof | Soil Model



PASS/Start-Prof | Soil Model

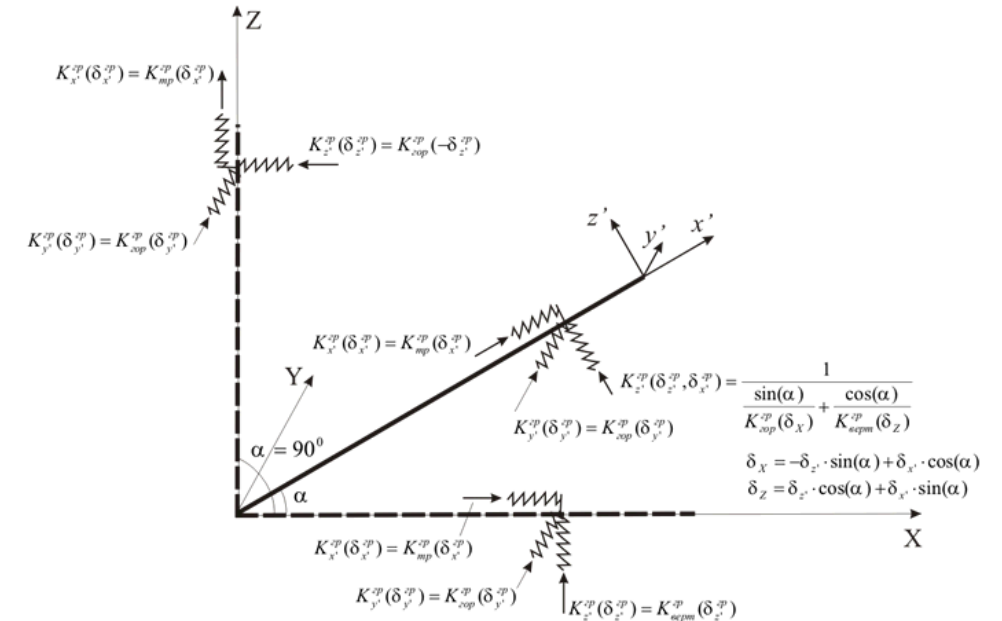
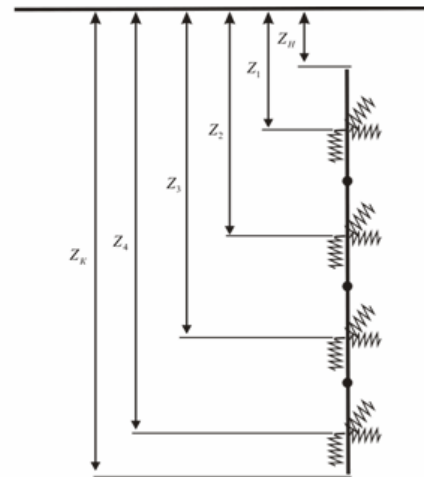
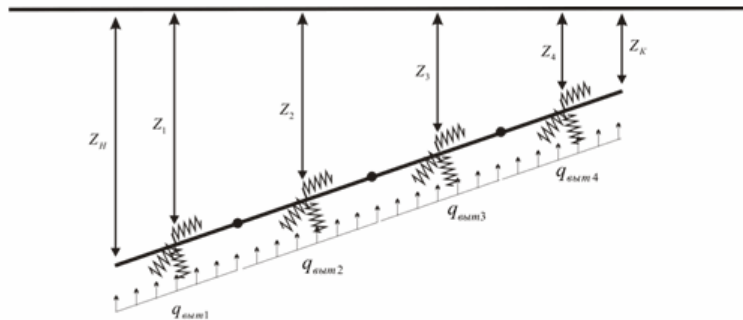
You can define the depth from the surface at any node of the pipeline. Depth, water height and subsidence can change along the pipe length



PASS/Start-Prof | Soil Model

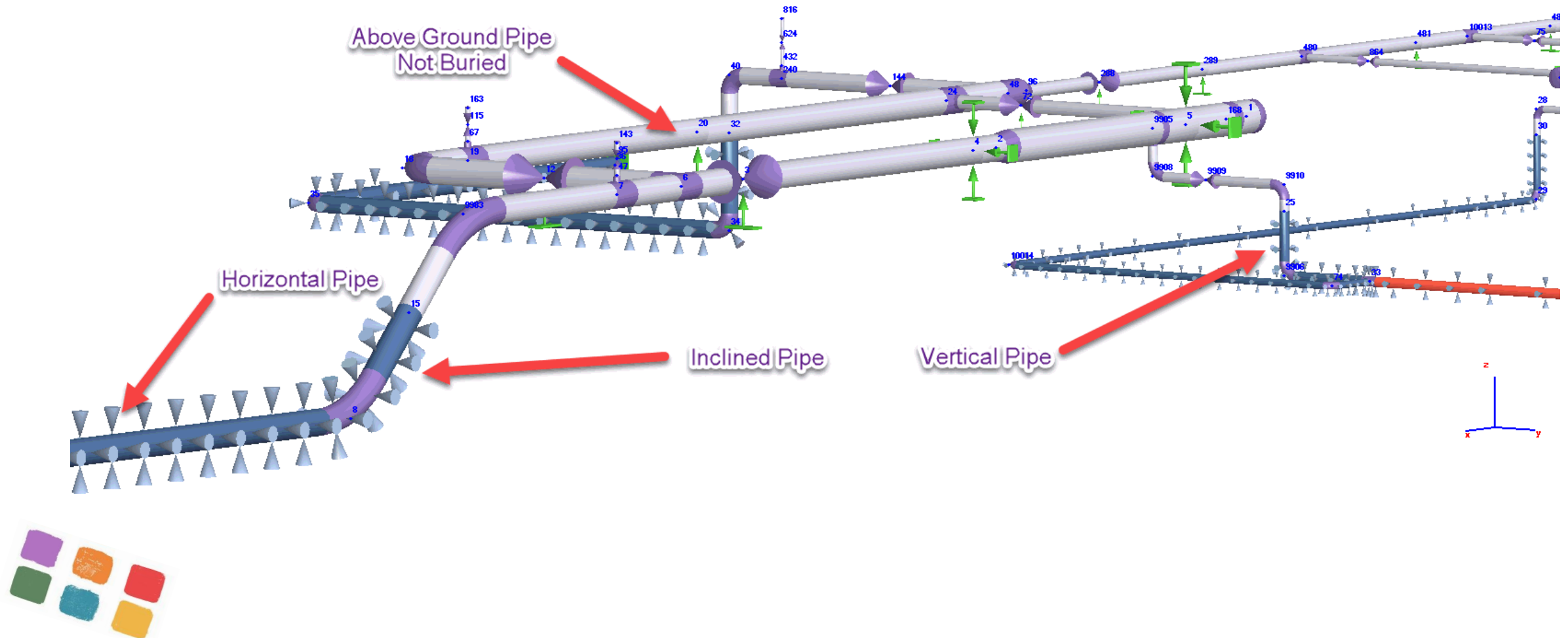
For inclined and vertical pipes:

- The bilinear properties of each soil spring (stiffness, water buoyancy, spring displacement etc.) are calculated using individual depth of the specific spring
- Stiffness of the springs K3, K4 and K5 are also depend on the pipe angle to the horizontal plane (from 0 to 90 degrees). For vertical pipe elements the vertical stiffness K4 behavior becomes the same as behavior of horizontal spring K3

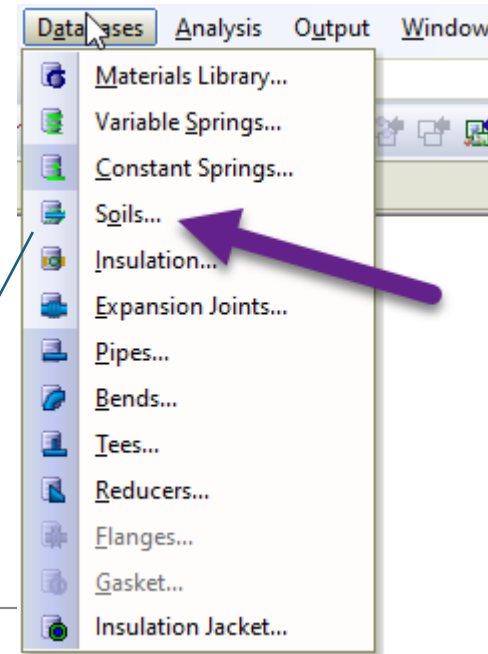


PASS/Start-Prof | Soil Model

PASS/START-PROF can automatically calculate the mixed pipeline models with above ground pipes, horizontal pipes, inclined pipes, vertical pipes.



PASS/Start-Prof | Soil Model



Soil Database

Soils

Code	Type	Description	E Elastic Modulus kgf/sq.cm	ν Poisson's Ratio	e Void ratio(e)	ϕ Internal friction angle	γ Unit weight kgf/cub.m	γ_s Unit weight of solid kgf/cub.m	C Cohesion kgf/sq.cm	R_s Carrying capacity kgf/sq.cm	Longitudinal displacement resistance factor kgf/cub.m	
01	sand	large sand	300	0.3	0.65	30	1520	2660	0.01	1.5	270000	
02	sand	fine sand	300	0.38	0.65	30	1550	2660	0.02	1.6	210000	
03	loam	loam with a texture ranging from 0.3 to 0.75	400	0.33	0.42	19	2100	2710	0.1	2	350000	
04	sand	heavy fine sand	300	0.38	0.65	30	1700	2660	0.01	1.6	210000	
05	peat	wet peat	2.7	0.45	15.5	10	500	1600	0.02	0.14	100000	
06	peat	peat drv	2.7	0.45	15.5	10	500	1600	0.02	0.14	50000	

Buttons: Add, Delete, Print, Export..., Save, Close, Help

Pipe Properties

Pipe: 1-2 ☒ Pipe is Buried

Name:

Main Additional Soil

Properties

Insulation diameter: 530 mm

Submerged Pipe: No

Consider Soil Movements: No

Start Node (1)

Depth to the Top of Insulation: 1.445 m

Depth to the pipe Axis: 1.71 m

End Node (2)

Depth to the Top of Insulation: 2.485 m

Depth to the Pipe Axis: 2.75 m

Soil

Pipe Laying Method: Open trench

Backfill Soil Type: 03

Foundation Soil Type: 01

Insulation and Cushions

Insulation Type: Other

Factor for Friction Angle: 1

Buttons: OK, Cancel, Help

PASS/Start-Prof | Stress Analysis EN 13941

Input Stress														
Operating Mode		Expansion Stress Range							☒ Show Equations					
1 'Operation mode'		1 'Operation mode' (1-1A)							?					
Object	Start End node	A1 Force Controlled Membrane, (MPa)			A1 Force Controlled Membrane+Bending, (MPa)			A2 Force+Deformation, (MPa)			Expansion Stress Range, (MPa)			Notes
		calcu- lated	allow- able	%	calcu- lated	allow- able	%	calcu- lated	allow- able	%	calcu- lated	allow- able	%	
Buried pipe	33	79.84	191.40	41.7	149.41	287.10	52.0	39.92	293.10	13.6	160.63	500	32.1	
	34	71.34	191.40	37.3	139.50	287.10	48.6	138.88	293.10	47.4	496.82	500	99.4	
Buried pipe	34	71.34	191.40	37.3	139.50	287.10	48.6	138.88	293.10	47.4	496.82	500	99.4	
	35	70.40	191.40	36.8	137.89	287.10	48.0	242.23	293.10	82.6	696.86	500	139.4	333
Buried pipe	35	70.40	191.40	36.8	137.89	287.10	48.0	242.23	293.10	82.6	696.86	500	139.4	333
	36	70.24	191.40	36.7	137.58	287.10	47.9	311.08	293.10	106.1	720.78	500	144.2	16,333
Buried pipe	36	70.24	191.40	36.7	137.58	287.10	47.9	311.08	293.10	106.1	720.78	500	144.2	16,333
	37	70.24	191.40	36.7	137.58	287.10	47.9	311.08	293.10	106.1	720.78	500	144.2	16,333
Buried pipe	37	70.24	191.40	36.7	137.58	287.10	47.9	311.08	293.10	106.1	720.78	500	144.2	16,333
	38	70.22	191.40	36.7	137.53	287.10	47.9	310.78	293.10	106.0	722.78	500	144.6	16,333
Buried pipe	38	70.22	191.40	36.7	137.53	287.10	47.9	310.78	293.10	106.0	722.78	500	144.6	16,333
	39	70.22	191.40	36.7	137.53	287.10	47.9	310.78	293.10	106.0	723.12	500	144.6	16,333
Buried pipe	39	70.22	191.40	36.7	137.53	287.10	47.9	310.78	293.10	106.0	723.12	500	144.6	16,333
	40	70.13	191.40	36.6	137.35	287.10	47.8	238.61	293.10	81.4	714.57	500	142.9	333
Buried pipe	40	70.13	191.40	36.6	137.35	287.10	47.8	238.61	293.10	81.4	714.57	500	142.9	333

(Ultimate) Limit state (reference clause)	Limit state	Load combinations	Components to investigate	Load factors (γ_{gi})	Material factor (γ_{mi})	Limit value	Reference and remarks
Force controlled action (membrane stress)	A1	1, 2		Table 9	1,1	$\sigma_{m,j,m} \leq \sigma_d = \frac{R_e(T)}{\gamma_m}$	7.2.2.2
Force controlled action (membrane + bending stresses)	A1	2, 3, 4		Table 9	1,1	$\sigma_{res} \leq \begin{cases} 1,5 \cdot \frac{R_e(T)}{\gamma_m} & \text{for } \sigma_m \leq 0,67 \cdot \frac{R_e(T)}{\gamma_m} \\ 2,5 \cdot \frac{R_e(T)}{\gamma_m} - 1,5 \cdot \sigma_m & \text{for } \sigma_m > 0,67 \cdot \frac{R_e(T)}{\gamma_m} \end{cases}$ $\sigma_{j,res} \leq \begin{cases} 1,5 \cdot \frac{R_e(T)}{\gamma_m} & \text{for } \sigma_{j,m} \leq 0,67 \cdot \frac{R_e(T)}{\gamma_m} \\ 2,5 \cdot \frac{R_e(T)}{\gamma_m} - 1,5 \cdot \sigma_{j,m} & \text{for } \sigma_{j,m} > 0,67 \cdot \frac{R_e(T)}{\gamma_m} \end{cases}$	7.2.2.2 Including forced displacements
Stepwise deformation plastic Force + deformation controlled	A2	2, 3, 4		Table 9	1,1	$\varepsilon_{max} = \alpha \cdot \Delta T \leq \frac{R_e(T)}{E} \left(\sqrt{1 - \frac{3}{4} \left(\frac{\sigma_p}{R_e(T)} \right)^2} + \sqrt{0,49 - \frac{3}{4} \left(\frac{\sigma_p}{R_e(T)} \right)^2} \right)$ see Formula (79)	7.2.2.3
Low cycle fatigue Force + deformation controlled	B1	4		Table 9		$\sum \frac{n_i}{N_i} \leq \frac{1}{\gamma_{fat}}$ and $S = k \cdot N^{-1/m}$	6.7 and 7.2.3

$$S = k \cdot N^{-1/m}; N = \left(\frac{k}{S} \right)^m$$

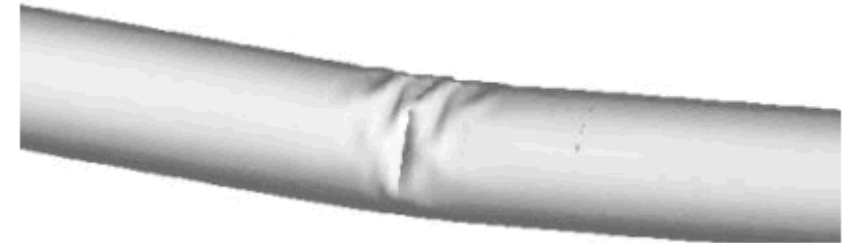
$$\sum \frac{n_i}{N_i} \leq \frac{1}{\gamma_{fat}}$$

Table 15 — Partial safety factor for fatigue

Project class	γ_{fat}
A	5
B	6,67
C	10

PASS/Start-Prof | Stress Analysis EN 13941

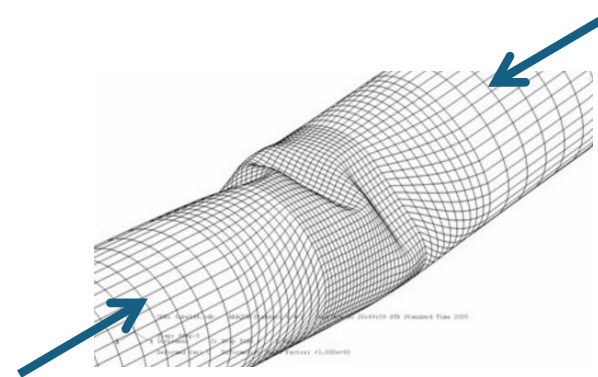
Automatic local pipe wall buckling check per EN 13941-2019 7.2.4.2



- For $(D_o - t_n)/(2t_n) \leq 28.7$
 $S_{st} = 0.0016E$
- For $(D_o - t_n)/(2t_n) > 28.7$
 $S_{st} = (0.0458 \cdot 2t_n/(D_o - t_n) + 0.00003)E$

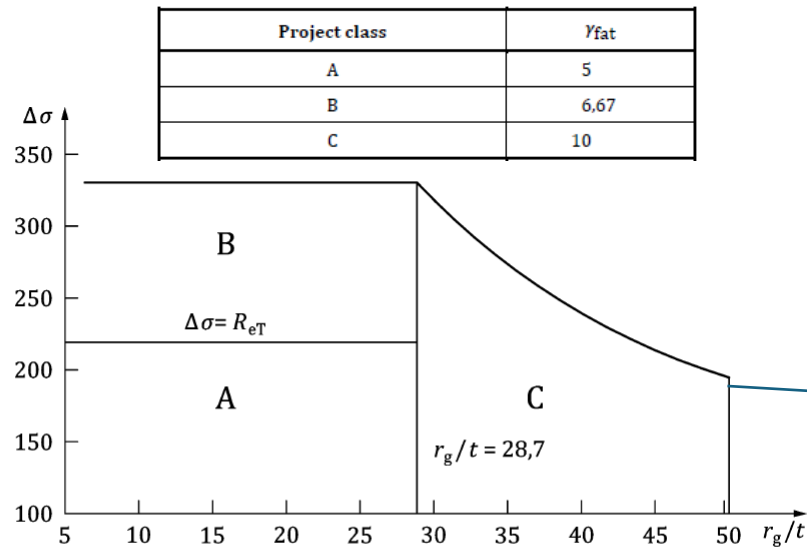
Local buckling	C1	1,3,4	Table 2	1,1	$\varepsilon \leq \frac{1}{2} \left(0,25 \frac{t}{r_m} - 0,0025 \right) \quad (\text{for uniform } \varepsilon)$ for $\frac{rm}{t} \leq 28,7$: $\Delta \varepsilon \leq 0,16 \%$ for $\frac{rm}{t} > 28,7$: $\left(4,58 \frac{t}{r_m} + 0,003 \right) \%$
----------------	----	-------	---------	-----	---

Input Stress Stability								
Operating Mode								
1 'Operation mode' ?								
Object	Start End node	C1 Local Buckling in Hot Condition, (MPa)		C1 Local Buckling in Cold Condition, (MPa)		C1 Local Buckling in Test Condition, (MPa)		Notes
		calculated	allowable	calculated	allowable	calculated	allowable	
Buried pipe	8	317.54	198.41	7.92	198.41	16.62	198.41	1
Buried pipe	8	317.54	198.41	7.92	198.41	16.62	198.41	1
	9	318.59	198.41	10.40	198.41	16.63	198.41	1
Buried pipe	9	318.59	198.41	10.40	198.41	16.63	198.41	1
	10	318.77	198.41	10.95	198.41	16.63	198.41	1
Buried pipe	10	318.77	198.41	10.95	198.41	16.63	198.41	1
	11	318.80	198.41	11.06	198.41	16.63	198.41	1
Buried pipe	11	318.80	198.41	11.06	198.41	16.63	198.41	1
	12	318.81	198.41	11.08	198.41	16.63	198.41	1



PASS/Start-Prof | Stress Analysis EN 13941

PASS/START-PROF can Automatically select the project class or it can be specified manually



Key

- A project class A (low)
- B project class B (medium)
- C project class C (high)

$\Delta\sigma$ axial stress range from the temperature difference

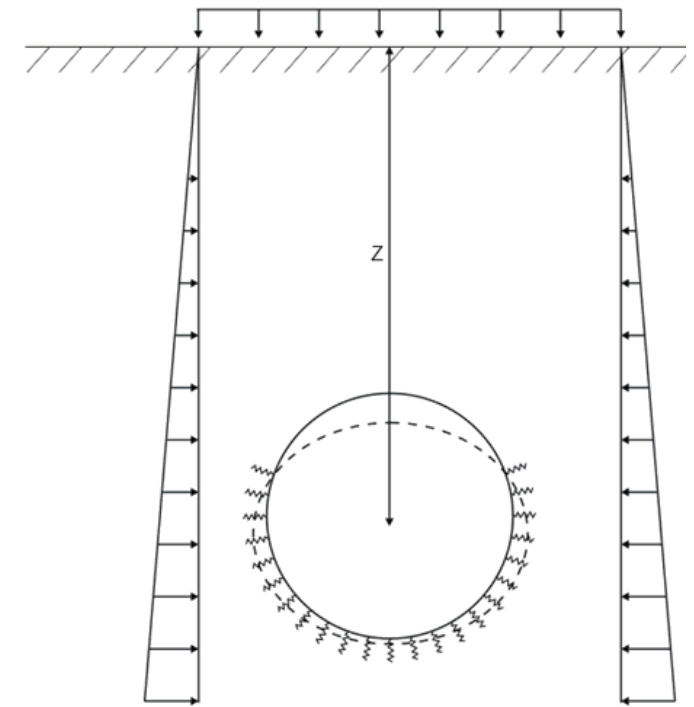
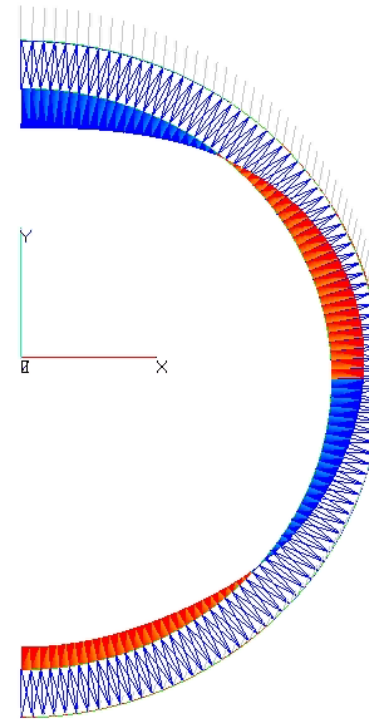
Table 14 — Equivalent full action cycles for $m = 4$ and $\Delta T_{ref} = 110\text{ }^{\circ}\text{C}$

Character of pipeline	Number of full action cycles	
	30 years operation	50 years operation
Transmission pipelines	100 to 250	170 to 420
Distribution pipelines	250 to 500	420 to 840
House connections	1000 to 2500	1700 to 4200

PASS/Start-Prof | Stress Analysis

Soil is modeled as discrete springs around pipe perimeter. The springs are switched off if tension is detected (usually at the top of the pipe). Flexible insulation also modeled if exist

Internal pressure and product hydrostatic pressure is applied. The analysis consider geometric nonlinearity, the additional internal pressure stiffening effect is taken into account



Stress in Polyurethane Insulation

According to 7.3.1, 7.3.2 EN 13941, 4.5.5.2 EN 253, allowable equivalent stress for PUR insulation layer, circumferential and longitudinal shear stresses are checked to guarantee PUR layer strength and adhesion to steel pipe

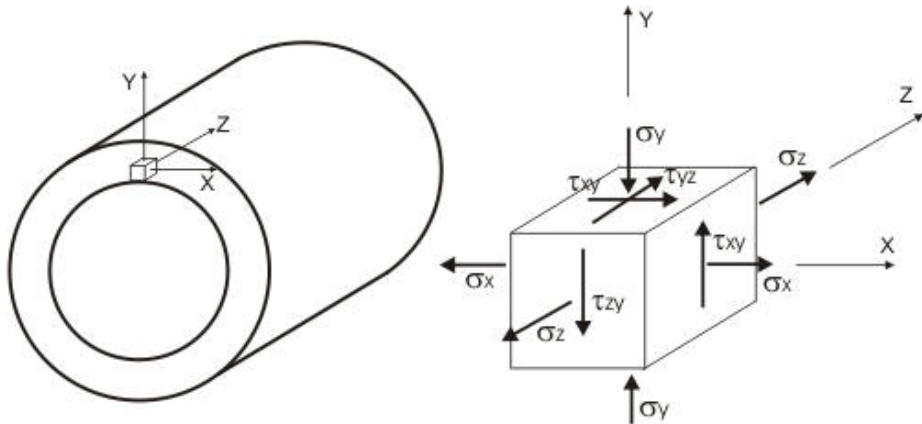
$$\sigma_{eq} = \sigma_1 - \sigma_3$$

$$\sigma^3 - I_1\sigma^2 + I_2\sigma - I_3 = 0$$

$$I_1 = \sigma_x + \sigma_y + \sigma_z$$

$$I_2 = \sigma_x\sigma_y + \sigma_x\sigma_z + \sigma_y\sigma_z - \tau_{yx}^2 - \tau_{zx}^2 - \tau_{zy}^2$$

$$I_3 = \sigma_x\sigma_y\sigma_z - \sigma_x\tau_{zy}^2 - \sigma_y\tau_{zx}^2 - \sigma_z\tau_{yx}^2 + 2\tau_{yx}\tau_{zx}\tau_{zy}$$

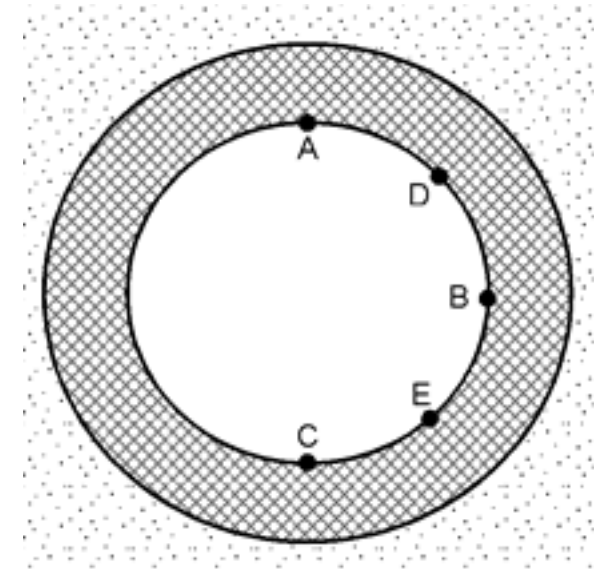
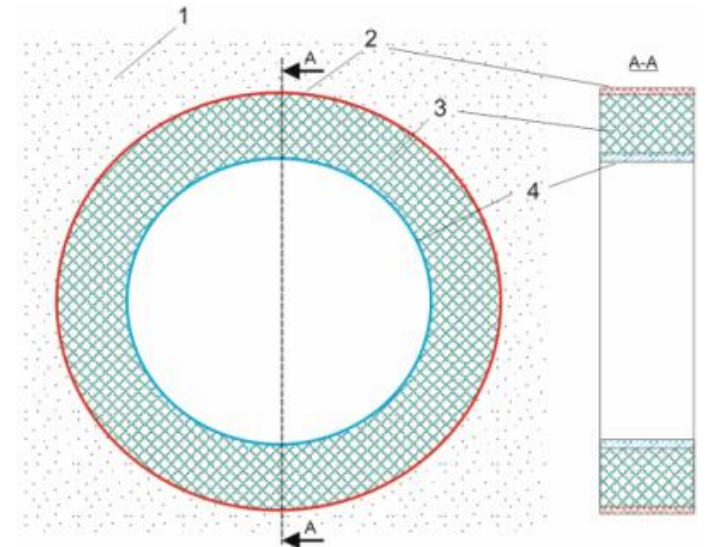


$$\sigma_z = \sigma \frac{E_{PUR}}{E}$$

$$\tau_{yz} = \frac{q_{fr}}{\pi D_c}$$

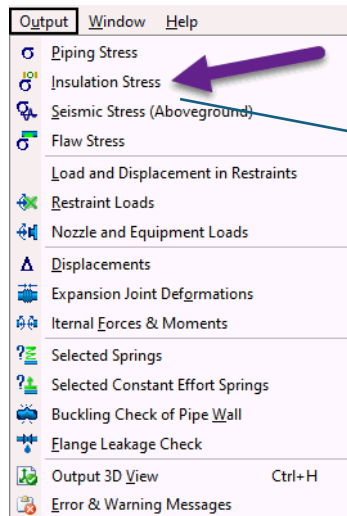
$$\sigma_{eq} \leq \frac{0.3}{2} = 0.15 \text{ MPa}$$

$$\tau_{yz} \leq \frac{0.08}{2} = 0.04 \text{ MPa}$$



PASS/Start-Prof | Stress Analysis

Calculate And Check Stresses In Polyurethane Insulation (EN 13941 7.3.1, 7.3.2, EN 253). Check Stresses from Surface Vehicle Loads



Object		Tangent stress, (MPa)				Equivalent stress, (MPa)		*
	Start End node	Hoop	Allowable	Axial	Allowable	Calculated	Allowable	
Underground	8			0.02	0.04	0.18	0.15	2
	62			0.02	0.04	0.18	0.15	2
Underground	62			0.02	0.04	0.18	0.15	2
	9			0.01	0.04	0.10	0.15	
Long Radius Induction Bend	9			0.01	0.04	0.08	0.15	
Underground	9			0.01	0.04	0.08	0.15	
	23			0.01	0.04	0.08	0.15	
Long Radius Induction Bend	23			0.01	0.04	0.08	0.15	

$$\sigma_{eq} \leq \frac{0.3}{2} = 0.15 \text{ MPa}$$

$$\tau_{yz} \leq \frac{0.08}{2} = 0.04 \text{ MPa}$$

Table 8 — Shear strength

Test temperature °C	Test clause	τ_{ax} min. MPa	Test clause	τ_{tan} min. MPa
23 ± 2	5.4.1.4	0,12	5.4.2	0,20
140 ± 2	5.4.1.5	0,08	—	—

7.3 Limit states for PUR and PE

7.3.1 Compressive stress

The maximum design compressive stress from soil loads and/or lateral displacements of the pipe system, at design temperature, for PUR qualities complying with EN 253, $\sigma_{PUR,d}$, calculated at the interface foam to steel service pipe, shall not exceed 0,15 MPa.

7.3.2 Limit state for σ_1 axial σ_1 shear stress

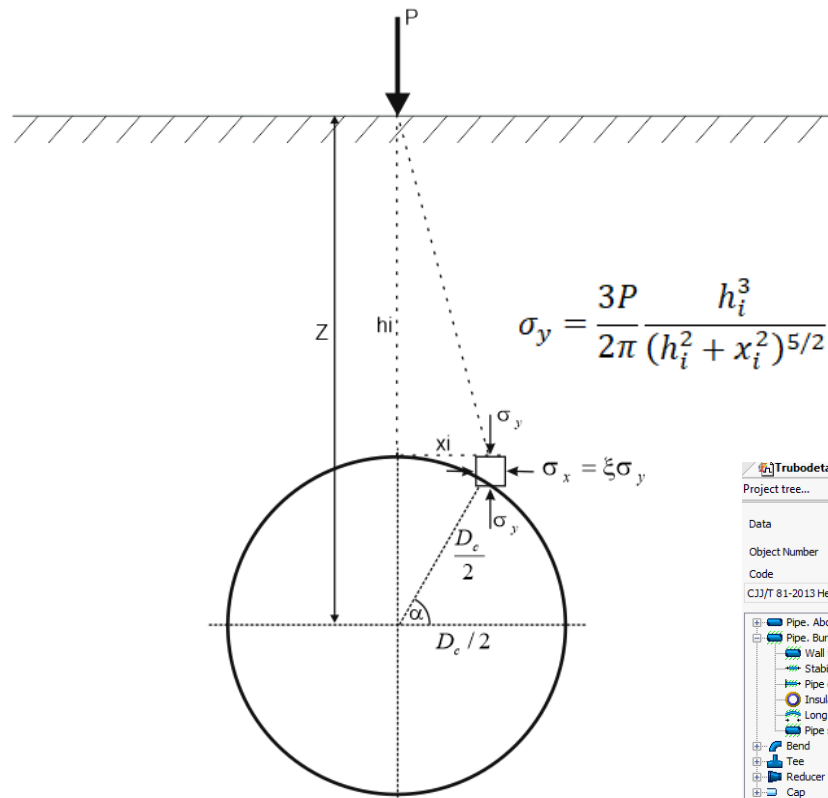
σ_1 The limit state for axial shear stress τ_{PUR} is given as the test requirement in EN 253, related to 140 °C in aged condition.

The value for γ_m related to this test requirement is 2. σ_1



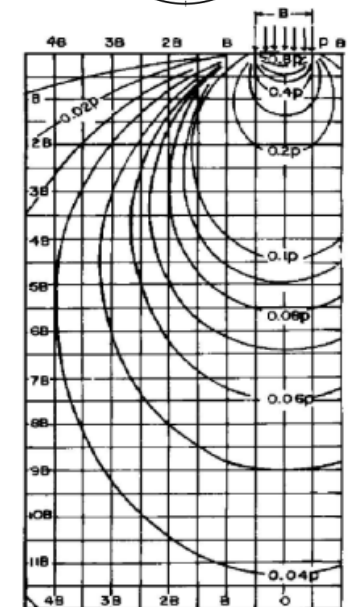
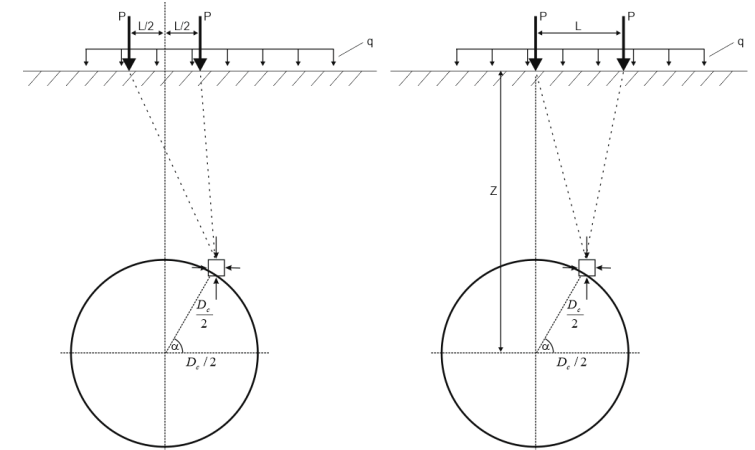
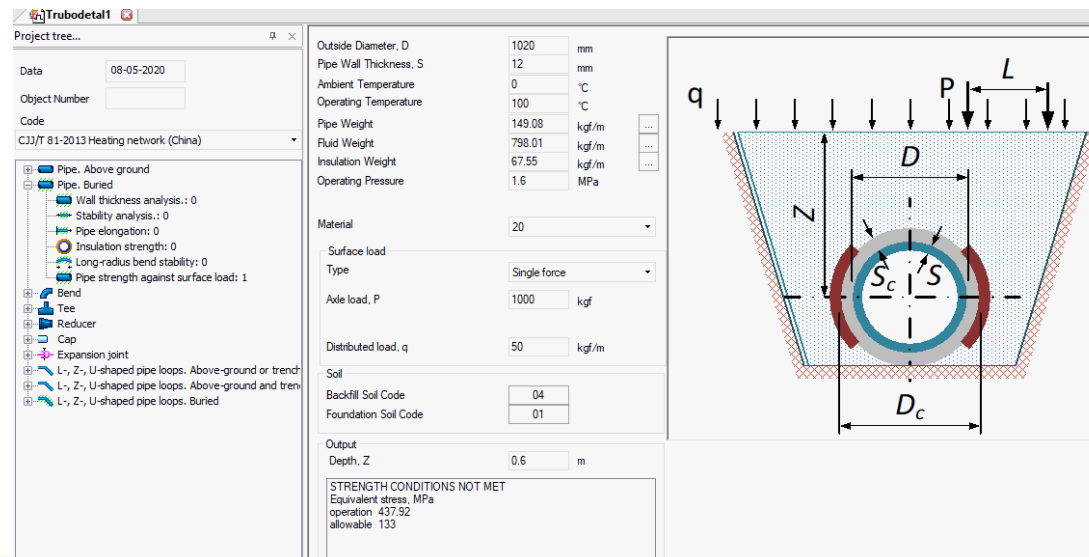
PASS/Start-Prof | Stress Analysis

Pipe and Insulation Strength Against the Surface Heavy Truck Loading



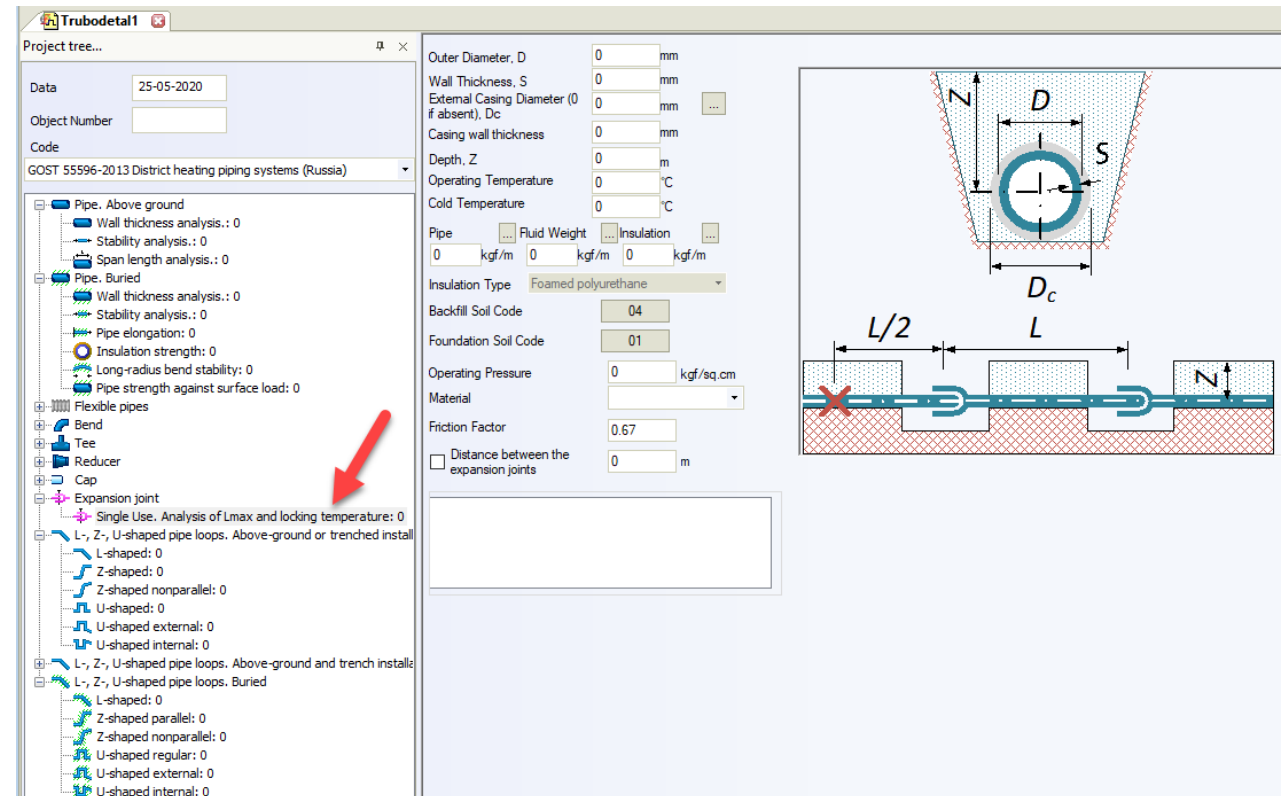
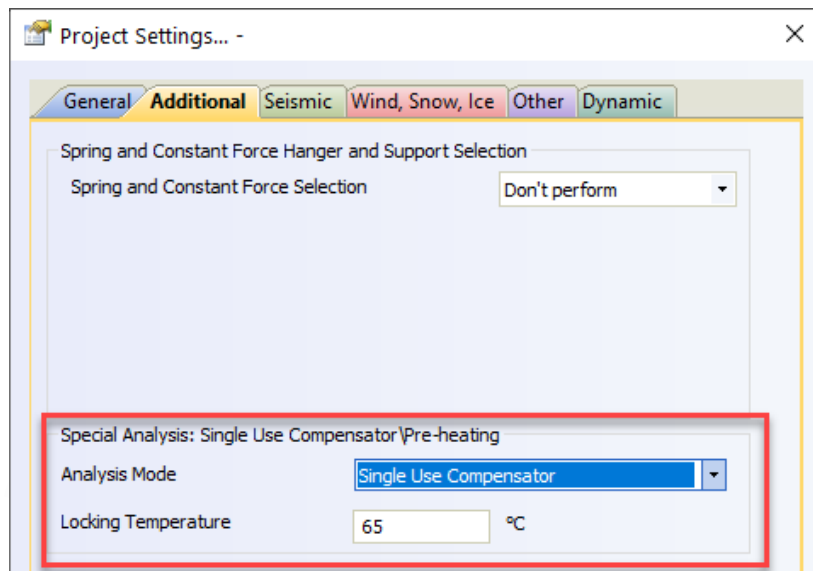
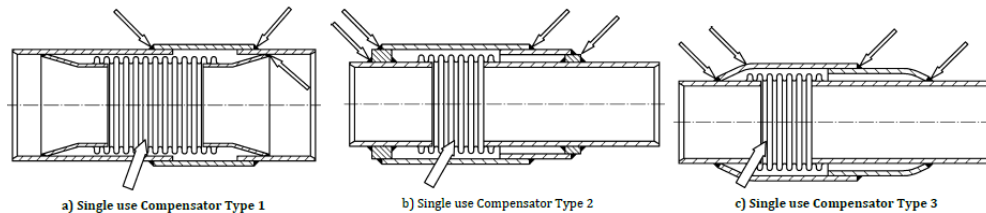
$$\sigma_y = \frac{3P}{2\pi} \frac{h_i^3}{(h_i^2 + x_i^2)^{5/2}}$$

$$\sigma_x = \xi \sigma_y$$



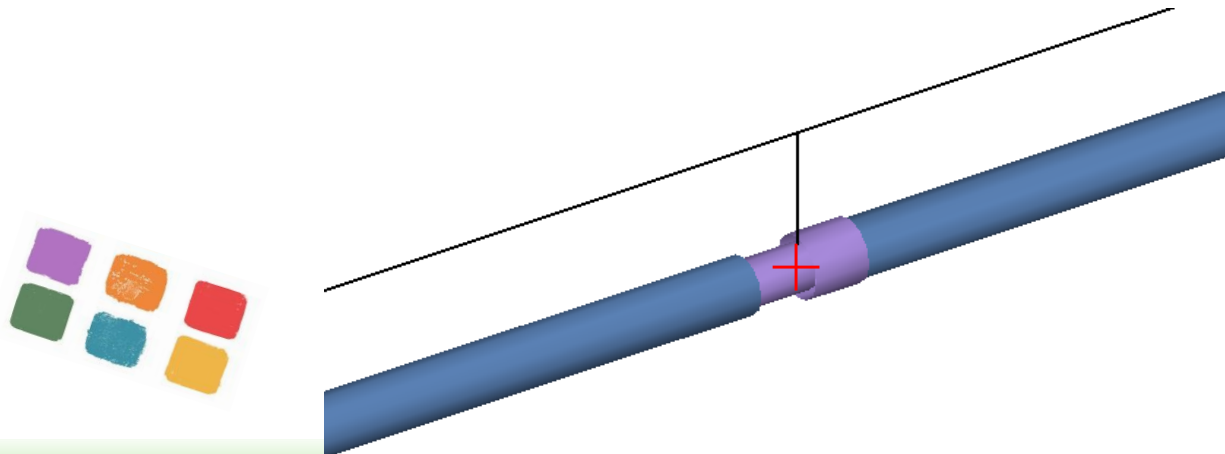
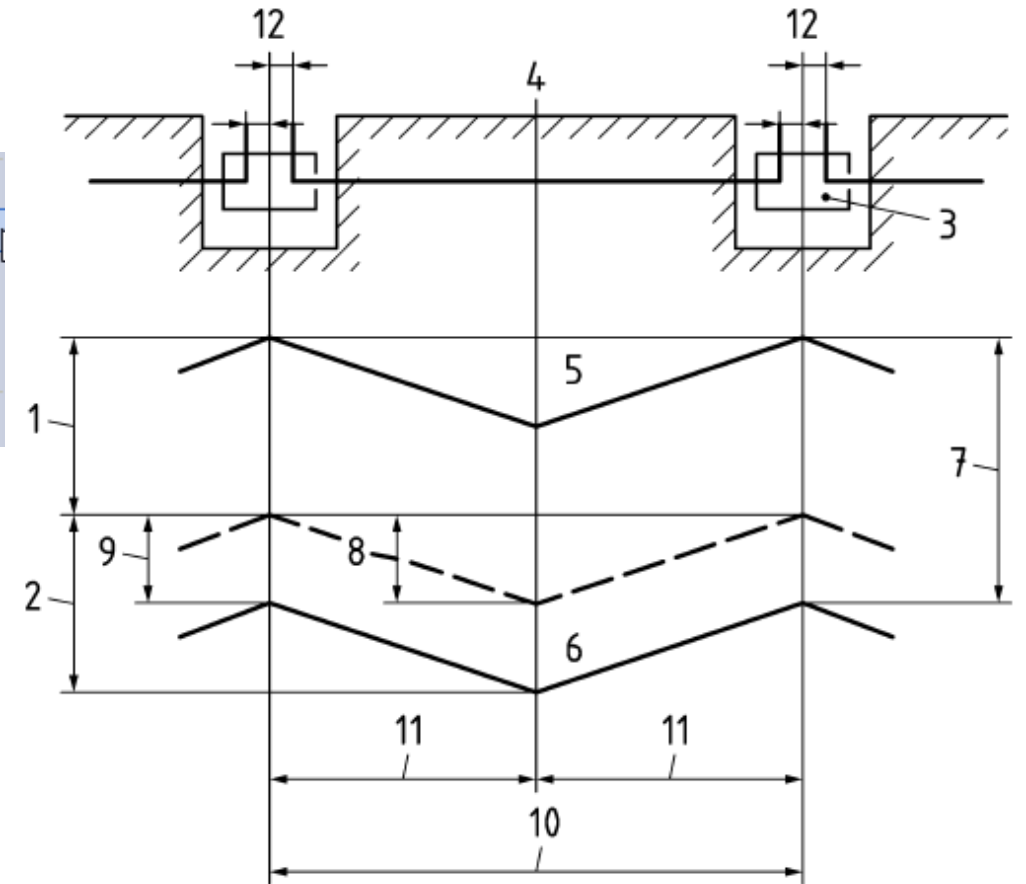
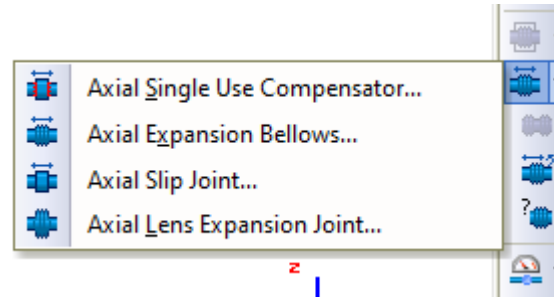
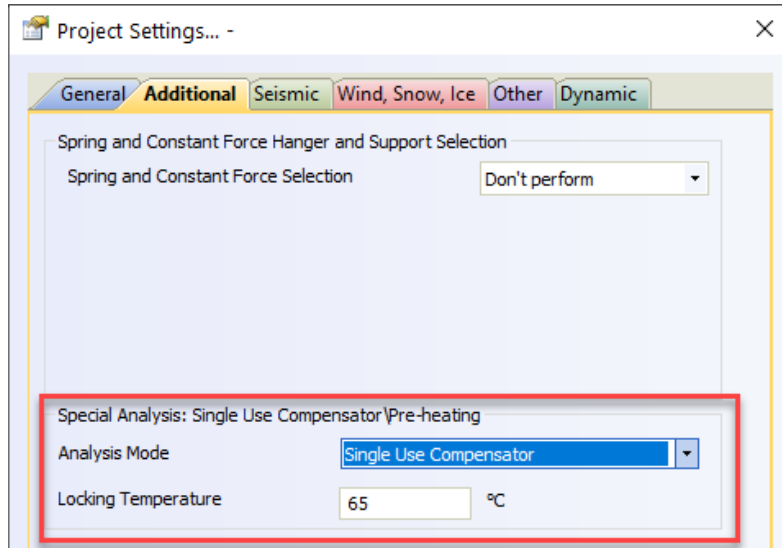
PASS/Start-Prof | Stress Analysis

- Pre-heating analysis for 3D model
- Single use compensators analysis for 3D model + Database + Distance Calculation

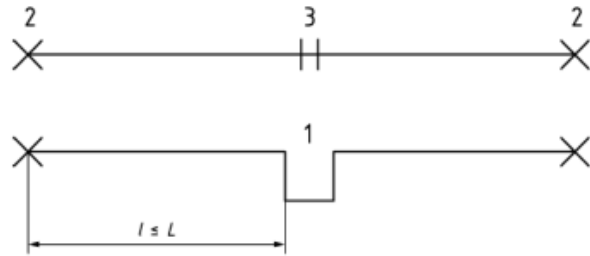


PASS/Start-Prof | Stress Analysis

PASS/START-PROF Automatically calculates networks with single use compensators

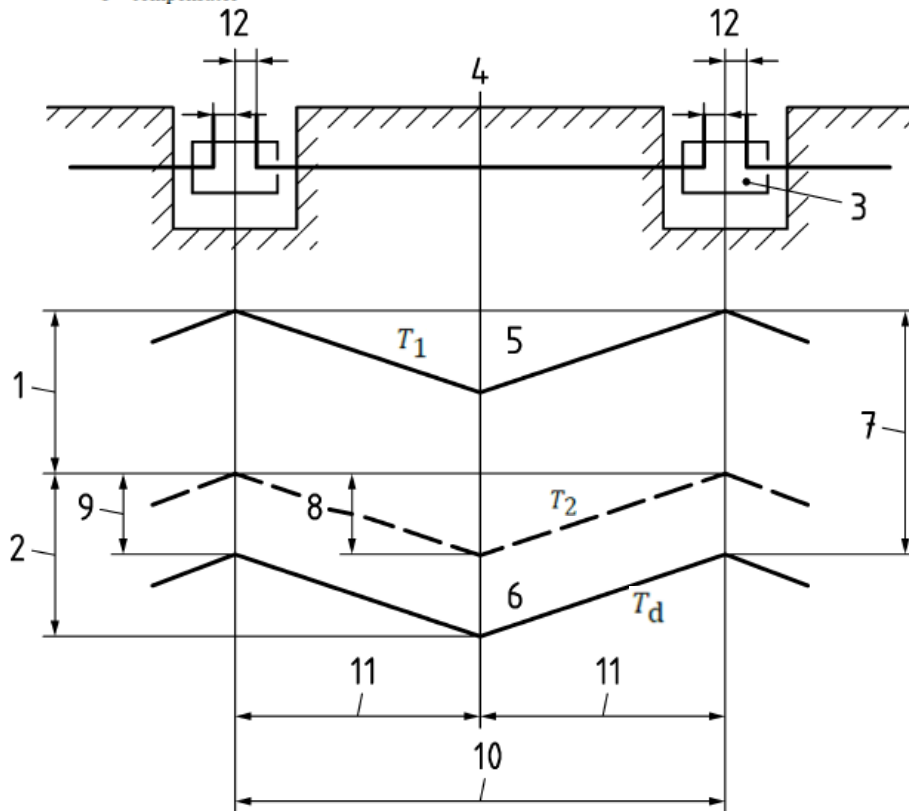


Singe Use Compensators

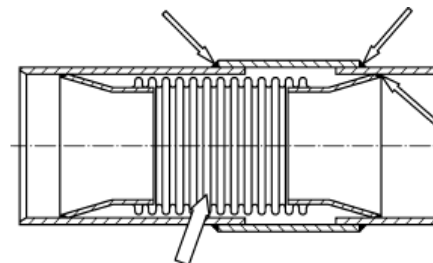
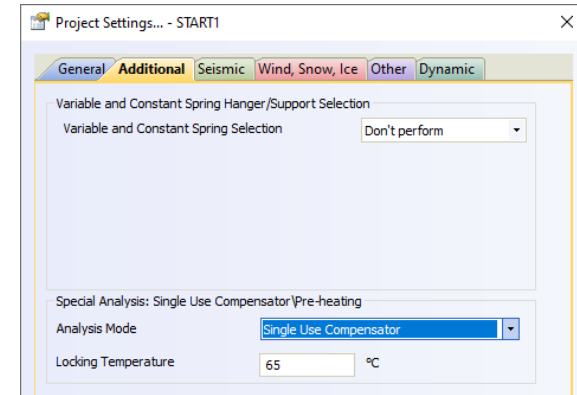


Key

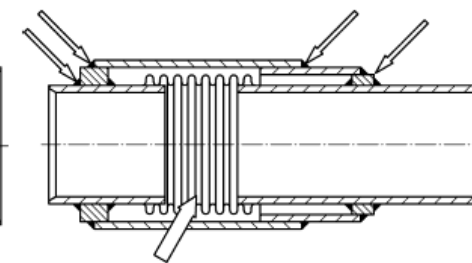
- 1 expansion loop
- 2 natural fixed point
- 3 compensator



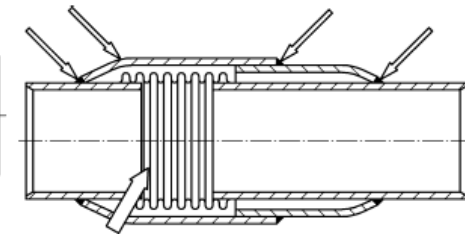
- 1 $\sigma_{t,all}$: allowable tensile stress
- 2 $\sigma_{c,all}$: allowable compressive stress
- 3 gap at SUC in cold condition
- 4 NFP: natural fixed point
- 5 axial stress diagram at temperature in cold condition
- 6 axial stress diagram at design temperature T_d
- 7 stress variation range from temperature increase ($T_d - T_1$)
- 8 axial stress at NFP, at the prestressing (closing) temperature T_2
- 9 axial stress at SUC, from temperature increase ($T_d - T_1$)
- 10 allowable distance between two SUC's
- 11 allowable length between NFP and SUC's
- 12 u displacement of one pipe end at SUC



a) Single use Compensator Type 1

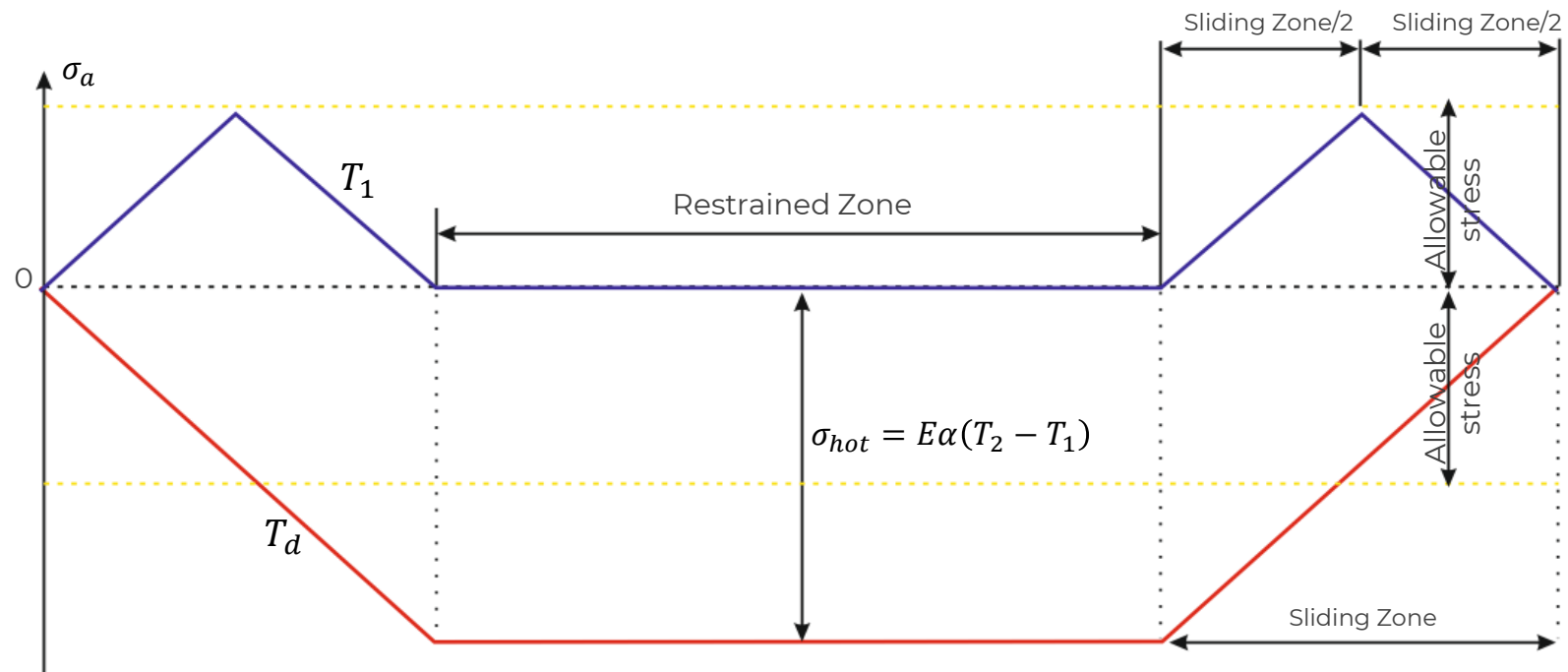
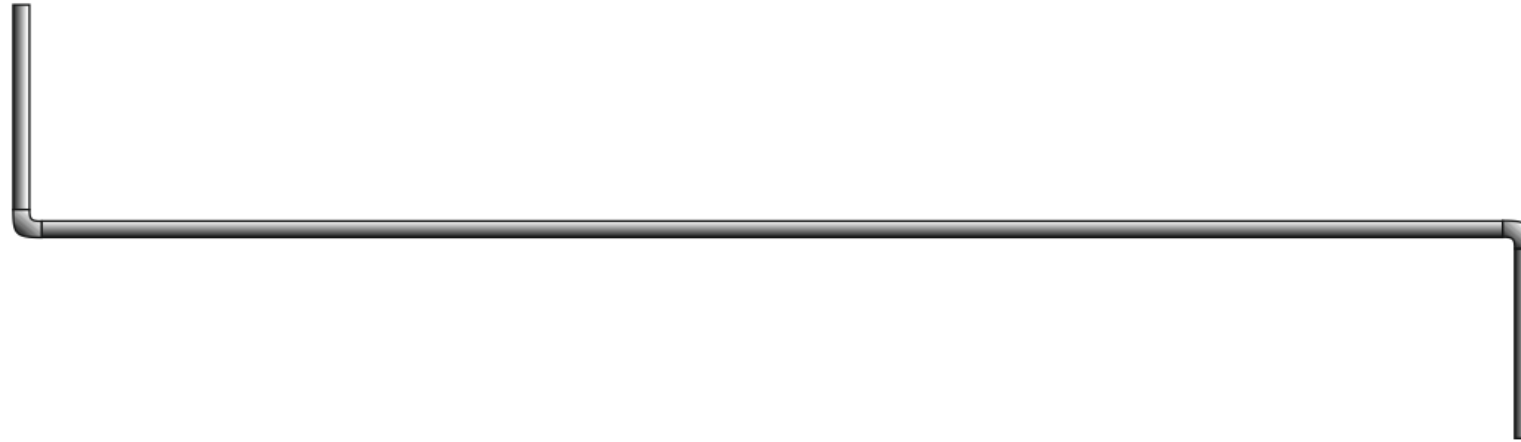


b) Single use Compensator Type 2



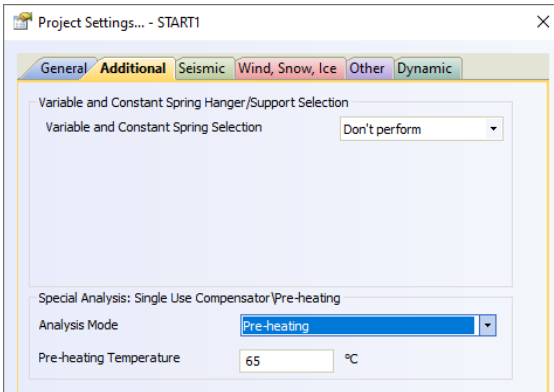
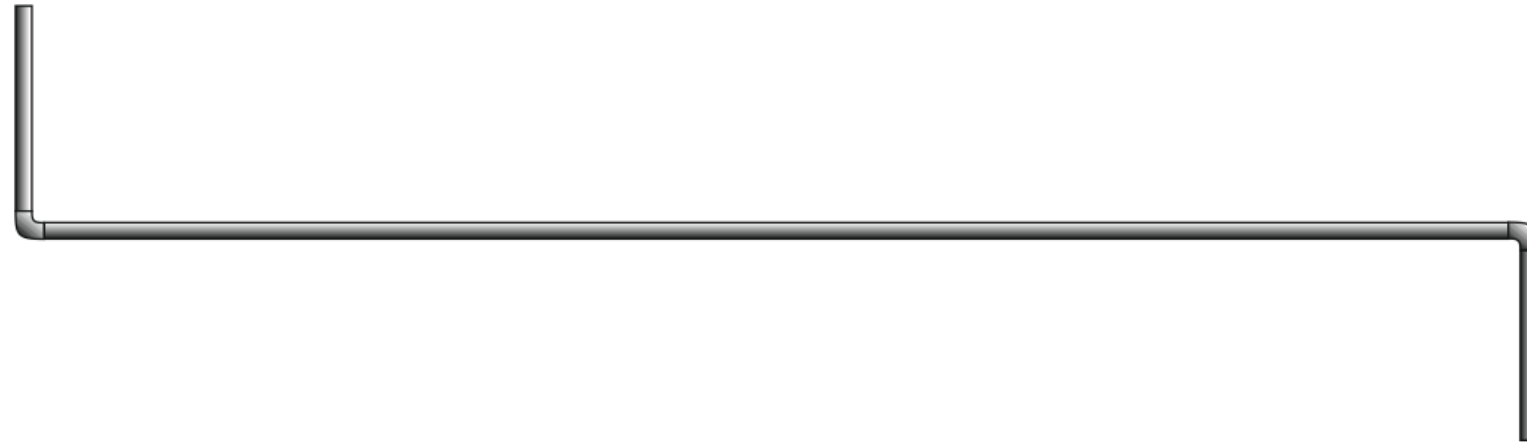
c) Single use Compensator Type 3

Cold Installation



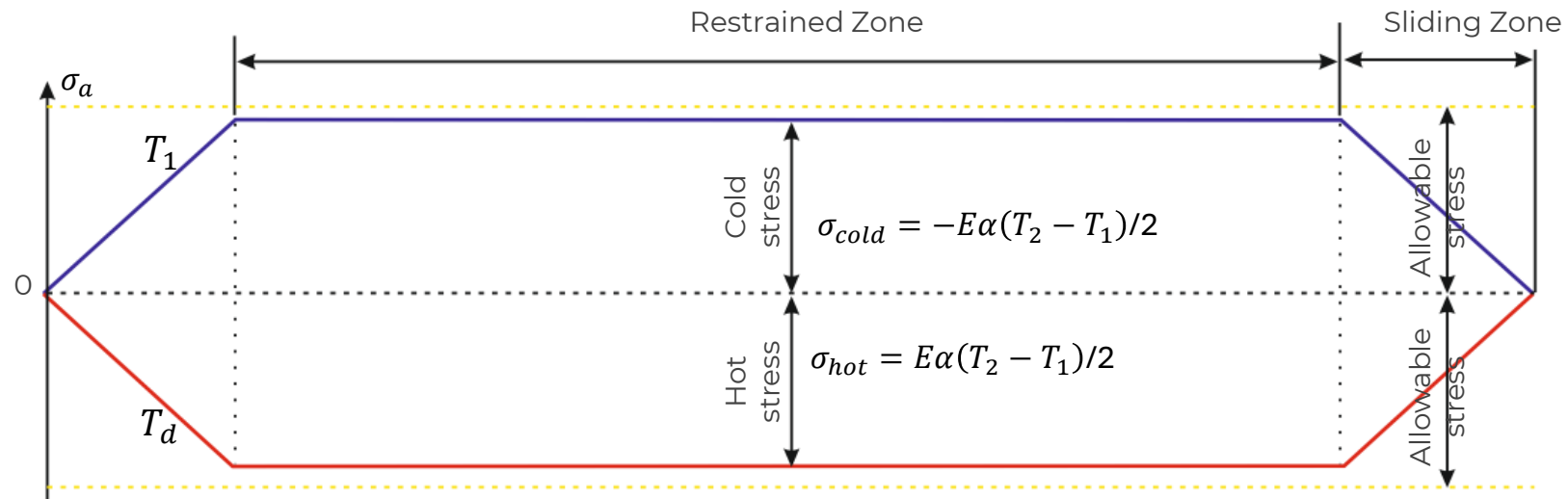
Pre-Heating

Pre-heating is just a way to perform pipeline cold spring (cold pull). We pull the pipe like a guitar string

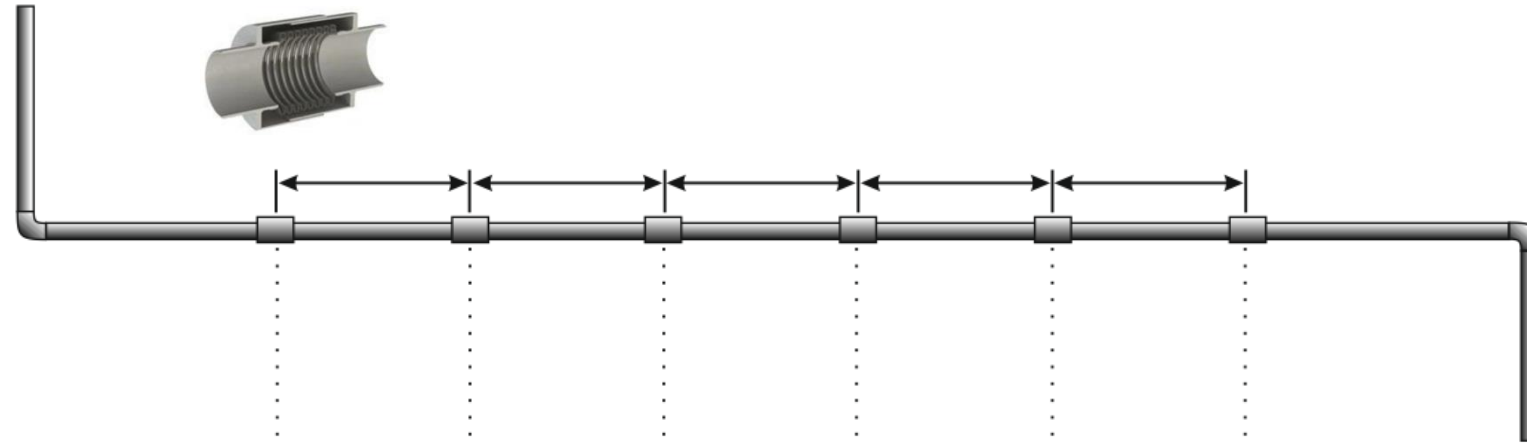
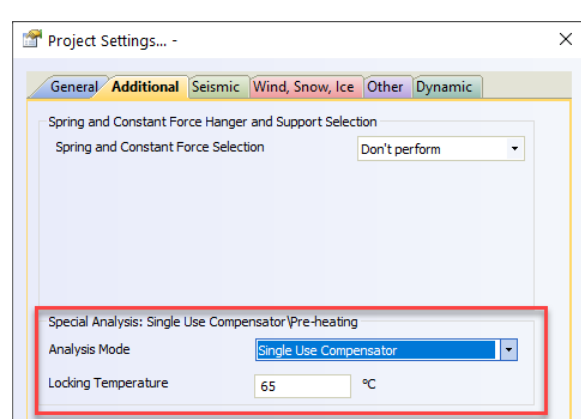


$$T_2 = \frac{T_1 + T_d}{2}$$

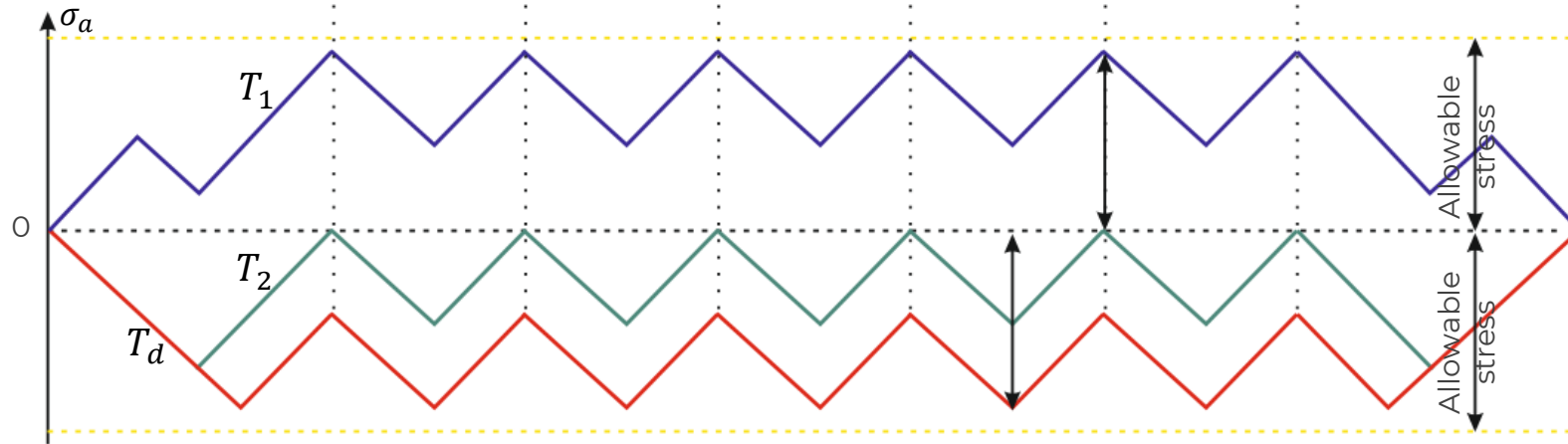
T_1 – cold temperature
 T_d – hot temperature
 T_2 – pre heating temp.



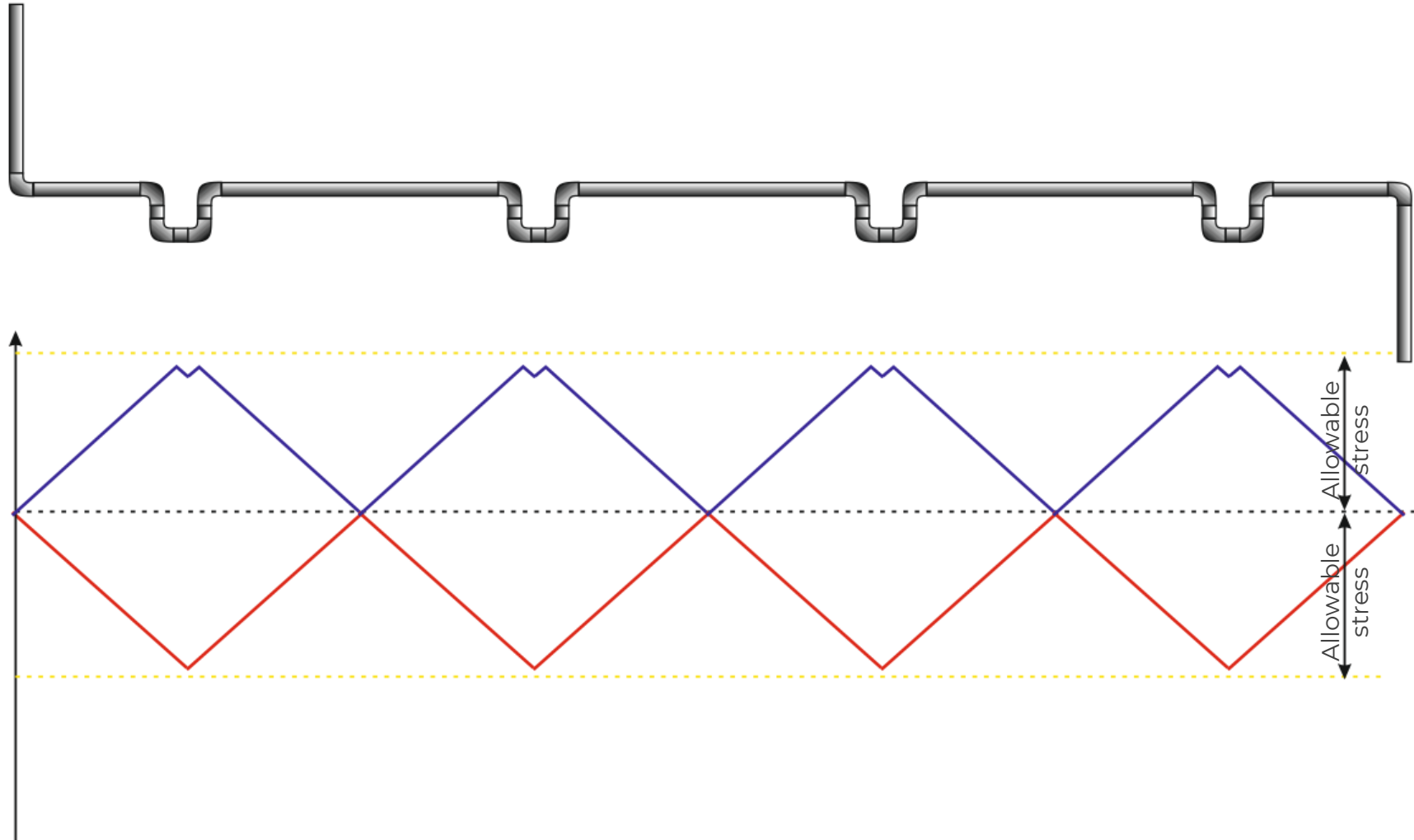
Single Use Compensator / One-time compensator / E-comp



T_1 – cold temperature
 T_d – hot temperature
 T_2 – locking temp.



Expansion Loops



Reliever



Custom Restraint

☐ Name ☒ Internal Restraint The element 14-7 is supported by the element 7-13

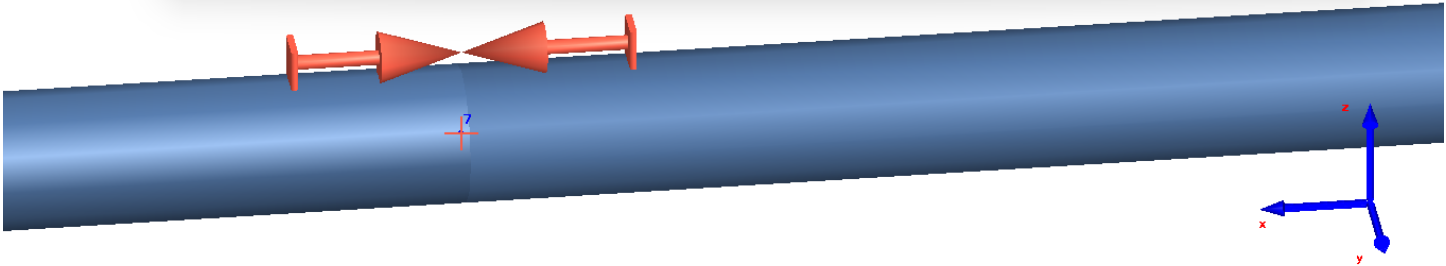
Support N 1 Local Axes of the Pipe

Weight 0 kgf ☐ Check Allowable Loads ☒ Use Gaps

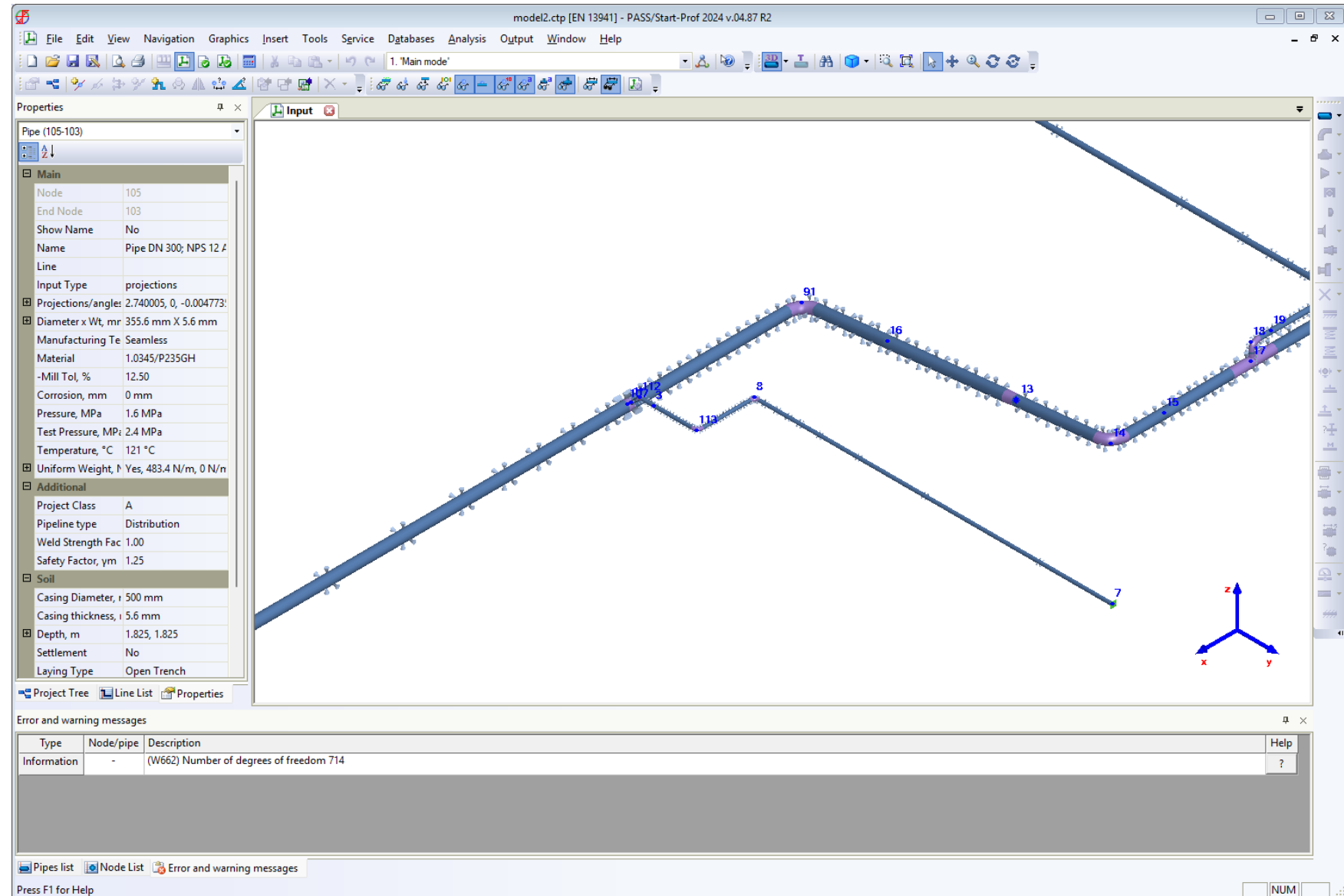
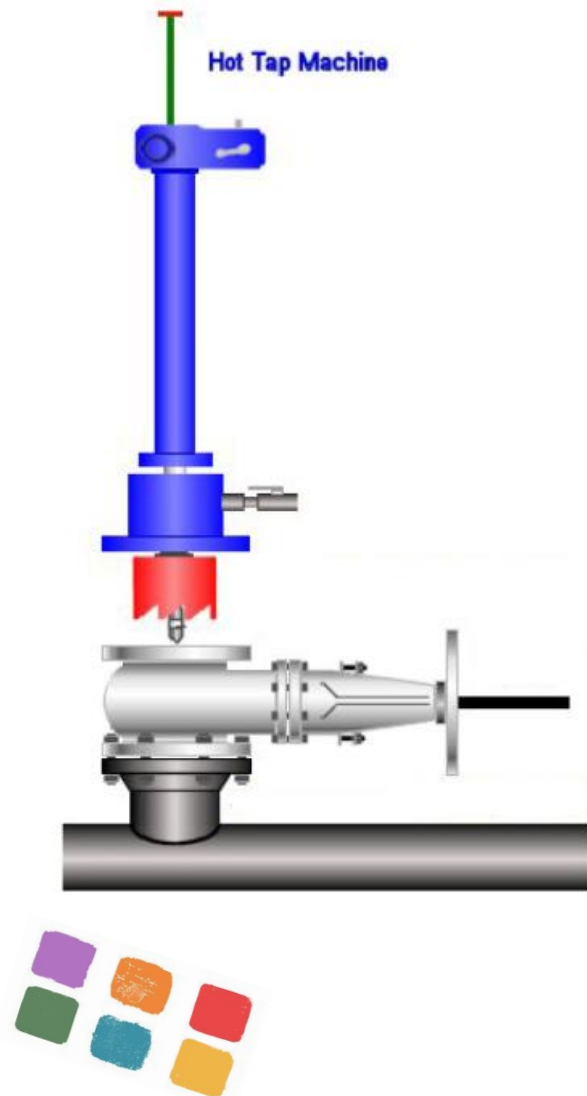
Linear Restraints	Local Axes	Restraint Direction	Flexibility, mm/kgf	Stiffness, kgf/mm	Force, kgf	Frict. Factor	Gap +, mm	Gap -, mm	Allowable Load, kgf	Precompression, kgf
1. Rigid double-acting	☐	+X	0	0	0	0	20	20	0	0
2. None	☐	Custom	0	0	0	0	0	0	0	0
3. None	☐	Custom	0	0	0	0	0	0	0	0

Rotational Restraints	Local Axes	Restraint Direction Around Axis	Flexibility, °/kgf-cm	Stiffness, kgf-cm/°	Moment, kgf-cm	Gap +, °	Gap -, °	Allowable Load, kgf-cm	Precompression, kgf-cm
4. None	☐	Custom	0	0	0	0	0	0	0
5. None	☐	Custom	0	0	0	0	0	0	0
6. None	☐	Custom	0	0	0	0	0	0	0

OK Cancel Help

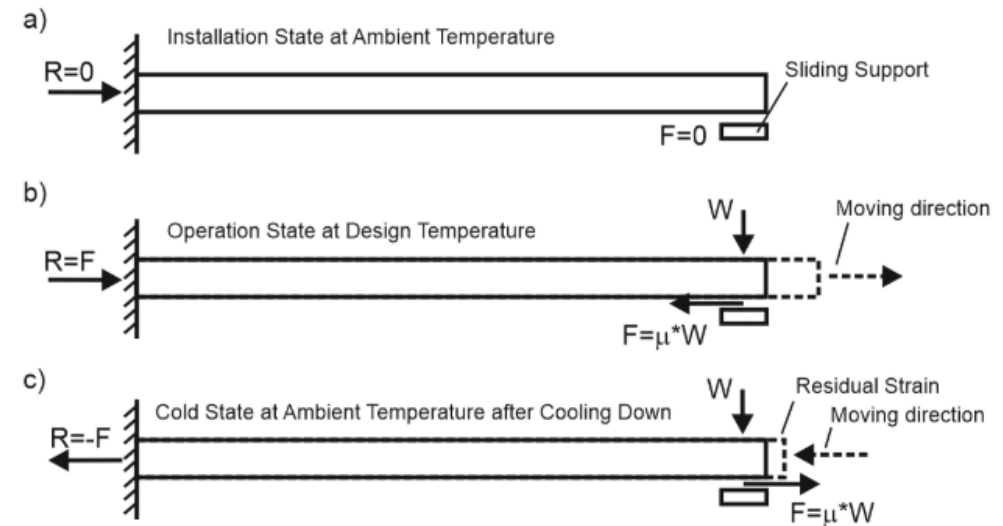
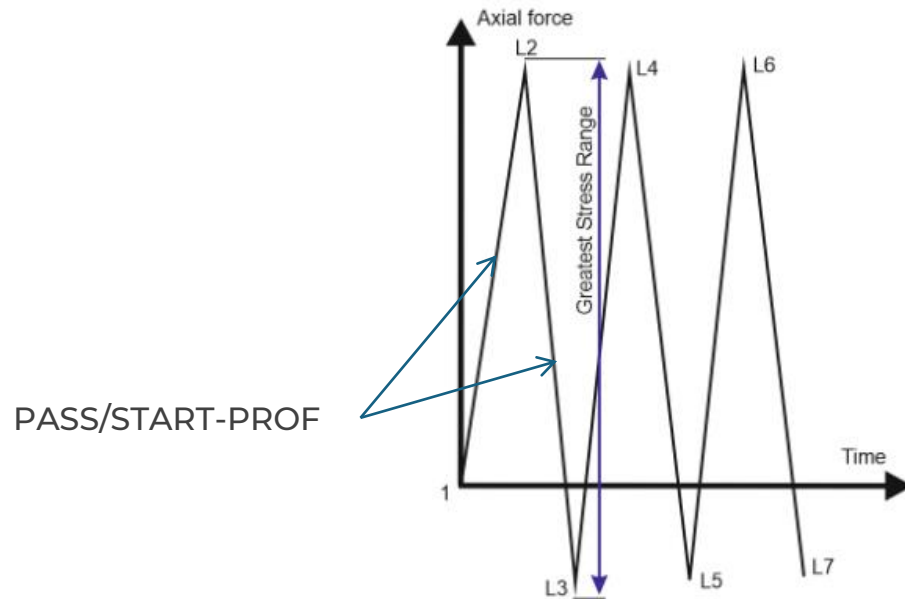


Hot Tap Modeling



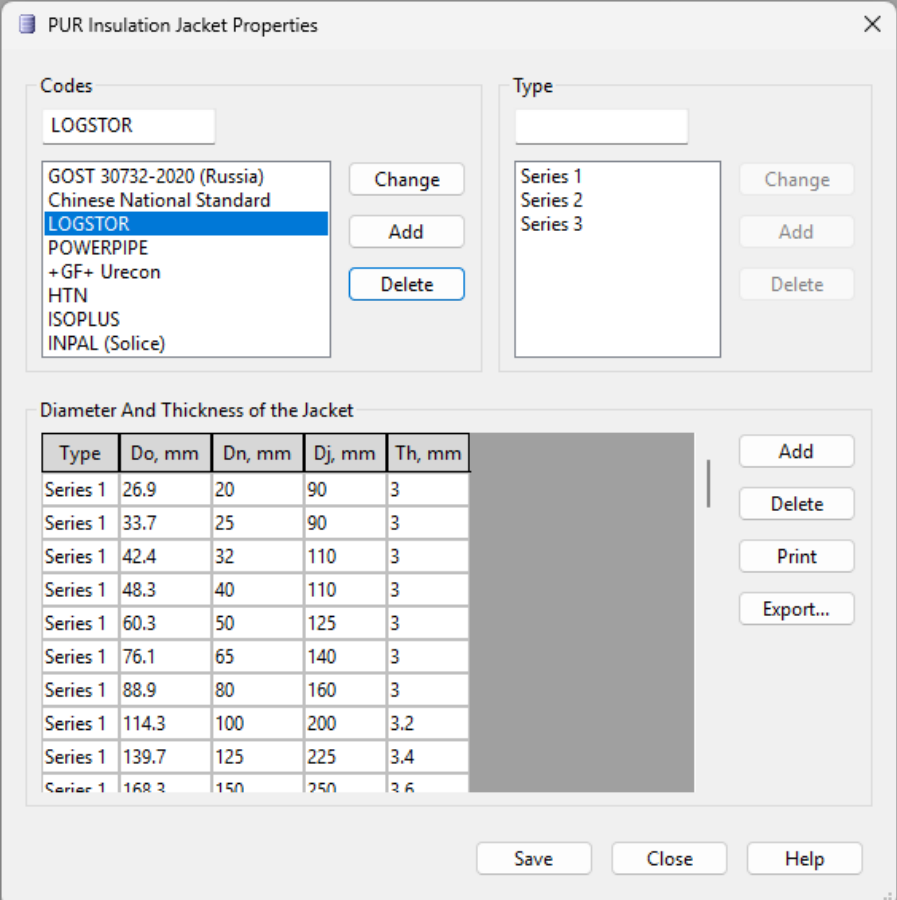
PASS/Start-Prof | Stress Analysis

PASS/START-PROF calculates the cold state after cooling down from the hot state. It allows to get more realistic expansion stress range



PASS/Start-Prof | Features

LOGSTOR, POWERPIPE, +GF+ Urecon Polyurethane Pre-insulated Pipe Jacket Sizes Database for district heating and district cooling networks



PUR Insulation Jacket Properties

Codes

LOGSTOR

Change

Add

Delete

GOST 30732-2020 (Russia)
Chinese National Standard
LOGSTOR
POWERPIPE
+GF+ Urecon
HTN
ISOPLUS
INPAL (Solice)

Type

Series 1
Series 2
Series 3

Change

Add

Delete

Diameter And Thickness of the Jacket

Type	Do, mm	Dn, mm	Dj, mm	Th, mm
Series 1	26.9	20	90	3
Series 1	33.7	25	90	3
Series 1	42.4	32	110	3
Series 1	48.3	40	110	3
Series 1	60.3	50	125	3
Series 1	76.1	65	140	3
Series 1	88.9	80	160	3
Series 1	114.3	100	200	3.2
Series 1	139.7	125	225	3.4
Series 1	168.3	150	250	3.6

Add

Delete

Print

Export...

Save

Close

Help



PASS/Start-Prof | Code Updates

Updated material database
EN 13480/EN 13941.

Added all piping materials by EN 10216-1-2013, EN 10216-2-2013, EN 10216-3-2013, EN 10216-4-2013, EN 10216-5-2013, EN 10217-1-2019, EN 10217-1-2019, EN 10217-2-2019, EN 10217-3-2019, EN 10217-4-2019, EN 10217-5-2019, EN 10217-6-2019, EN 10217-7-2014, EN 10220-2002 (2007), EN 10253-2-2007.

Added automatic material properties selection depending on wall thickness and seamless/welding option



Materials

Select Material

Code: EN 13480-2017/EN 13941-2019 (Metallic Industrial Piping, Europe)

Manufacturing method: seamless

Material: 1.0345/P235GH

Show

Add...

Material: 1.0345/P235GH Class: Carbon or Low Alloy Steel

Database can only be edited if database files are open for editing and if stress units are set as MPa (for ASME - ksi)

Data source: EN 10216-2-2013

Density: 7850 kg/m3

Factor A, %: 23

Properties

Th, cm	Yield Stress (Rp), ksi	Tensile Strength (Rm), ksi
1.6	34.084	52.214
4	32.633	52.214
6	31.183	52.214

Add

Delete

Temperature F	Yield Stress (Rp), ksi	Tensile Strength (Rm), ksi	Elastic Modulus ksi	Expansion Coeff. 1/F	Poisson's Ratio (v)	SRTt 10 000 h, ksi	SRTt 100 000 h, ksi	SRTt 200 000 h, ksi	SRTt 250 000 h, ksi
68	0	0	30714.787	6.277e-006	0.3	0	0	0	0
212	28.717	52.214	29887.637	6.611e-006	0.3	0	0	0	0
302	27.122	52.214	29353.463	6.804e-006	0.3	0	0	0	0
392	24.656	52.214	28805.946	6.986e-006	0.3	0	0	0	0
482	21.756	52.214	28245.375	7.155e-006	0.3	0	0	0	0
572	19.145	52.214	27671.460	7.313e-006	0.3	0	0	0	0
662	17.405	52.214	27084.493	7.458e-006	0.3	0	0	0	0
752	16.244	52.214	26484.181	7.592e-006	0.3	26.397	20.450	18.565	17.695
770	16.128	52.214	26362.495	7.617e-006	0.3	24.076	18.565	16.679	15.809
788	16.012	52.214	26240.228	7.642e-006	0.3	21.901	16.534	14.794	14.069
806	15.896	52.214	26117.526	7.667e-006	0.3	20.015	14.504	12.908	12.473
824	15.780	52.214	25994.389	7.691e-006	0.3	18.130	12.763	11.168	10.733
842	15.664	52.214	25870.527	7.714e-006	0.3	16.244	11.168	9.572	9.282

Add

Delete

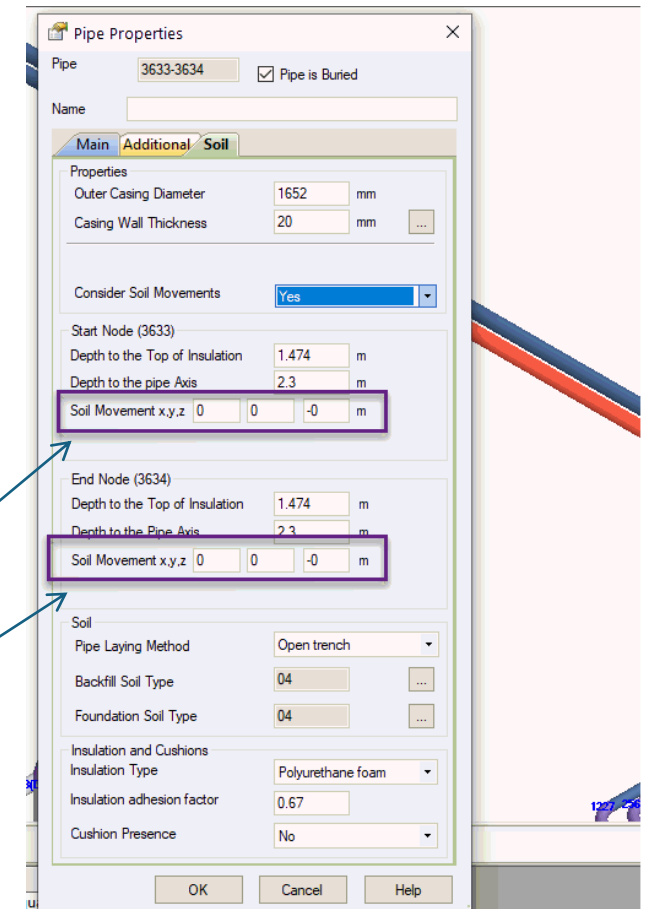
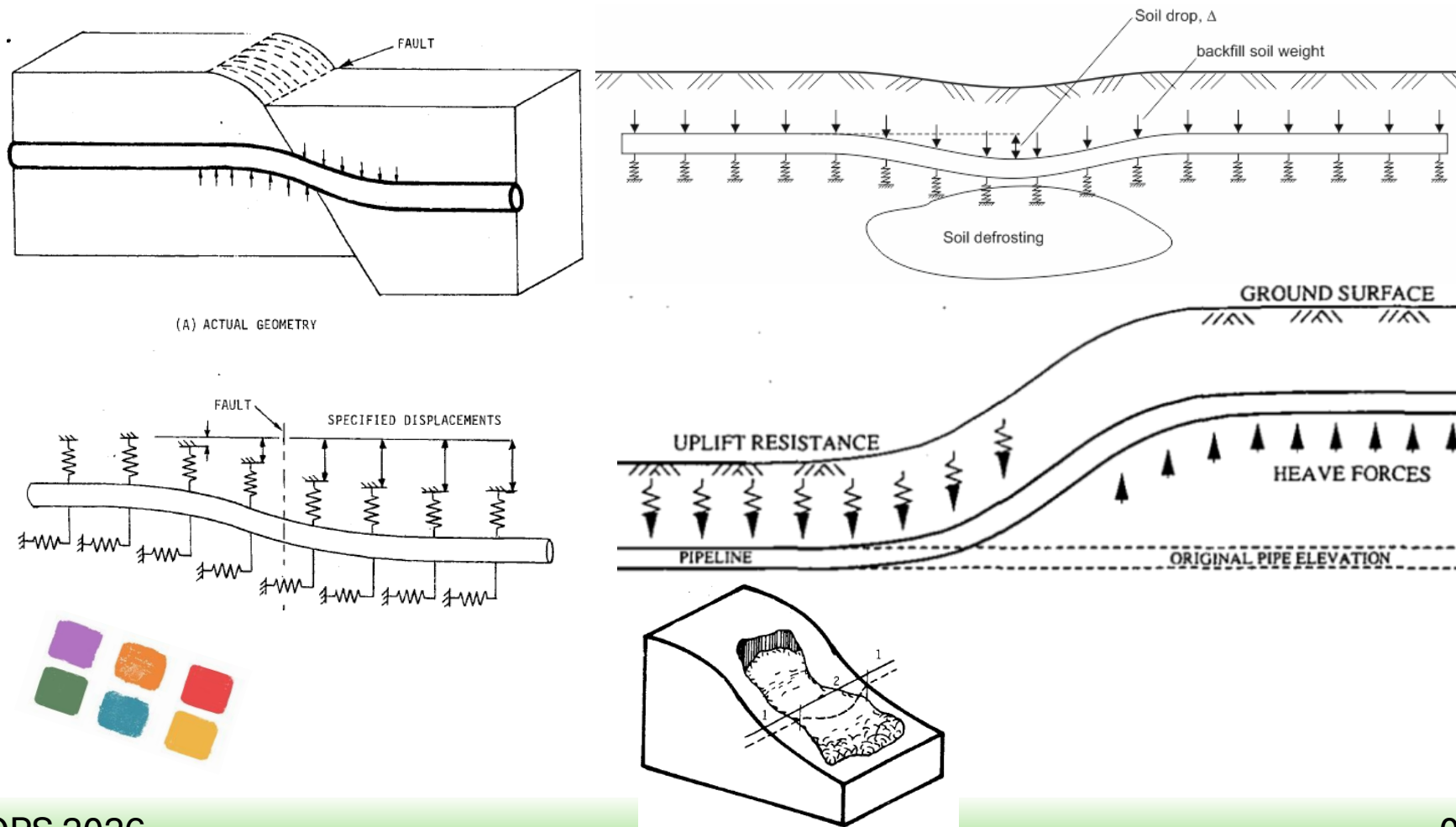
Print

Export...

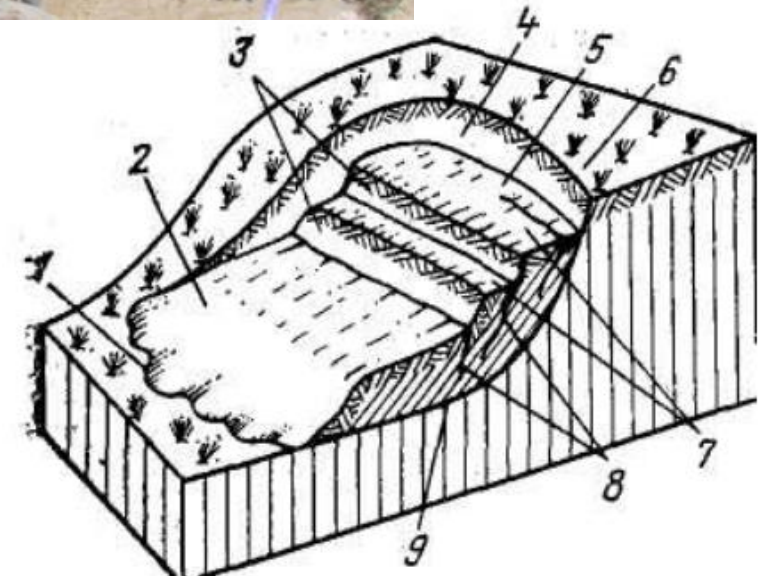
Save OK Cancel Help

PASS/Start-Prof | Features

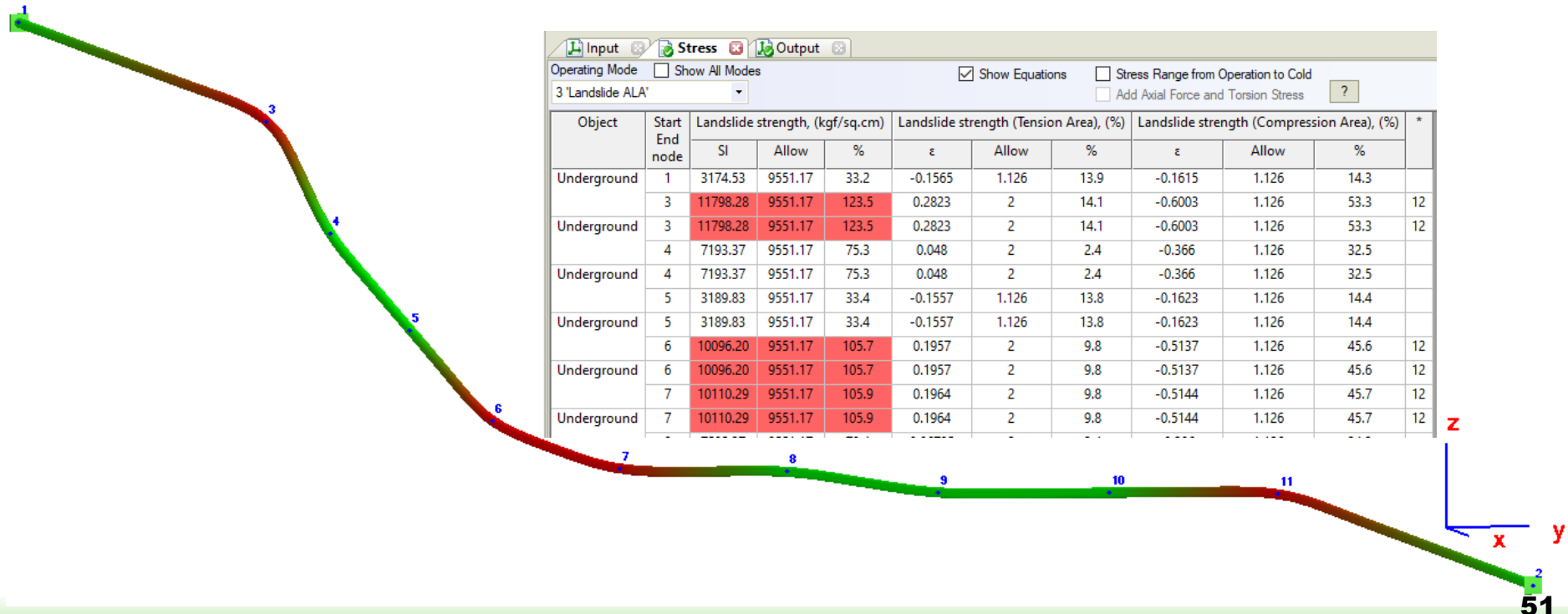
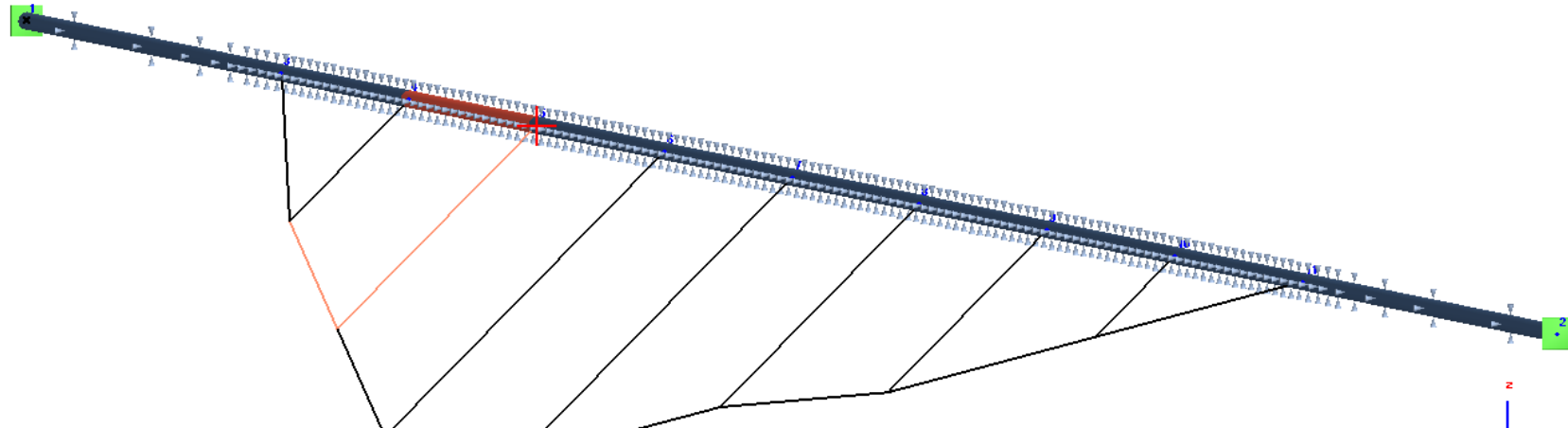
Modeling of Soil Subsidence, Frost Heaving, Landslide, Seismic Fault Crossing
It is modeled as soil movements at the both ends of the each pipe at X, Y, Z directions



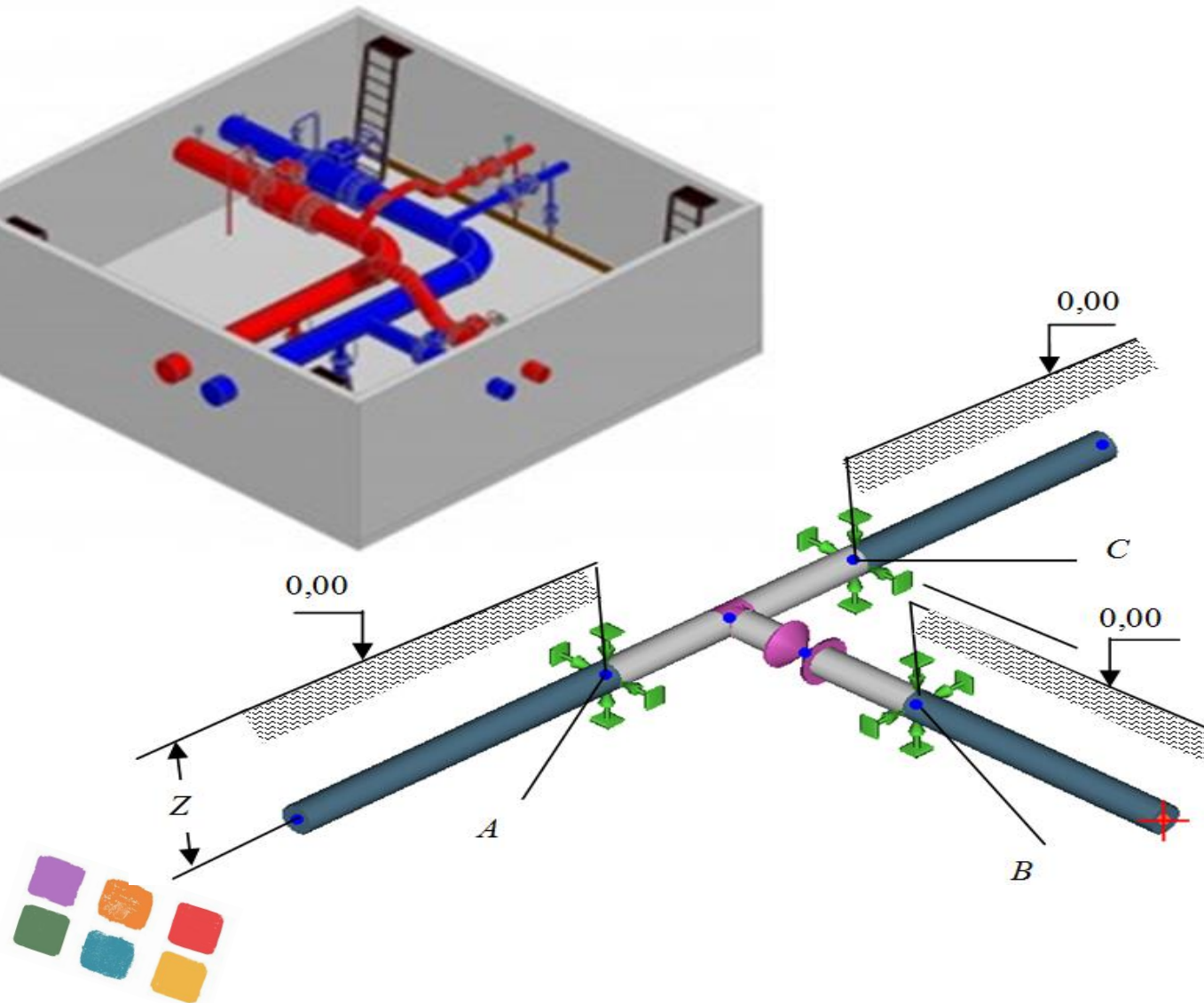
Landslide



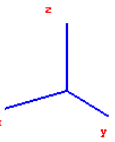
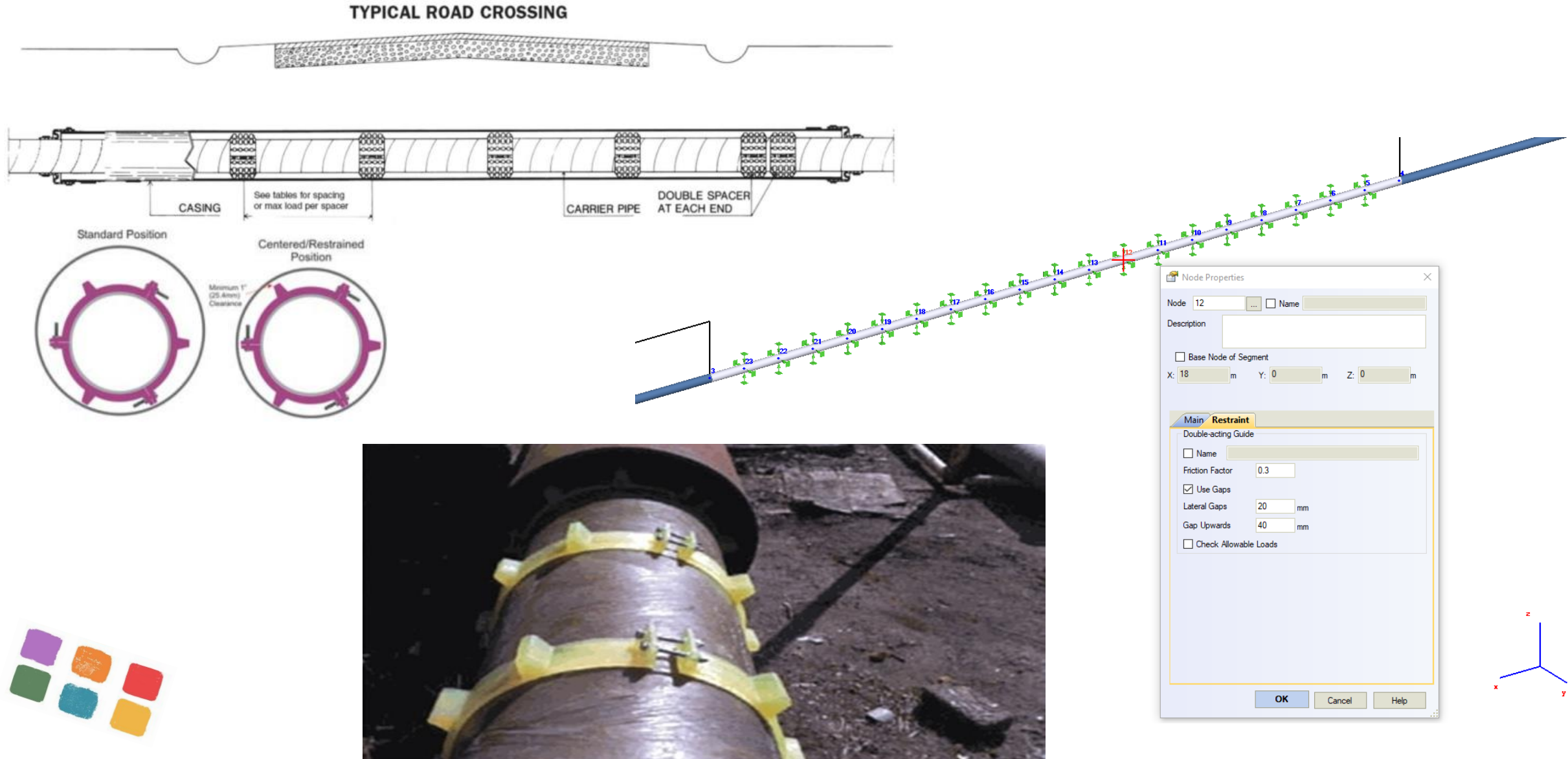
Landslide Example Model



Modeling the Pipe in Underground Chambers



Modeling Pipe in Casing with Spacers



Hvala na pažnji!
Thank you for your attention!

START-PROF Product Manager
Alex Matveev
PASS

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PASS VP on R&D and World market
Leonid Korelstein
PASS

korelstein@passuite.com

