



# Oil & Gas Gathering, Upstream and Midstream Pipelines.

Increase Productivity and  
Save your Time Twice with  
PASS/START-PROF 4.84

Dr. Alex Matveev,  
START-PROF Product Owner



PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE

# PASS/START-PROF

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## Smart Pipe Stress Analysis & Optimal Sizing

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Presenter:

Dr. Alex Matveev

START-PROF Product Owner

Development, Training, Support of  
START-PROF Since 2005

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# Webinar Agenda – Part 1

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## Introduction

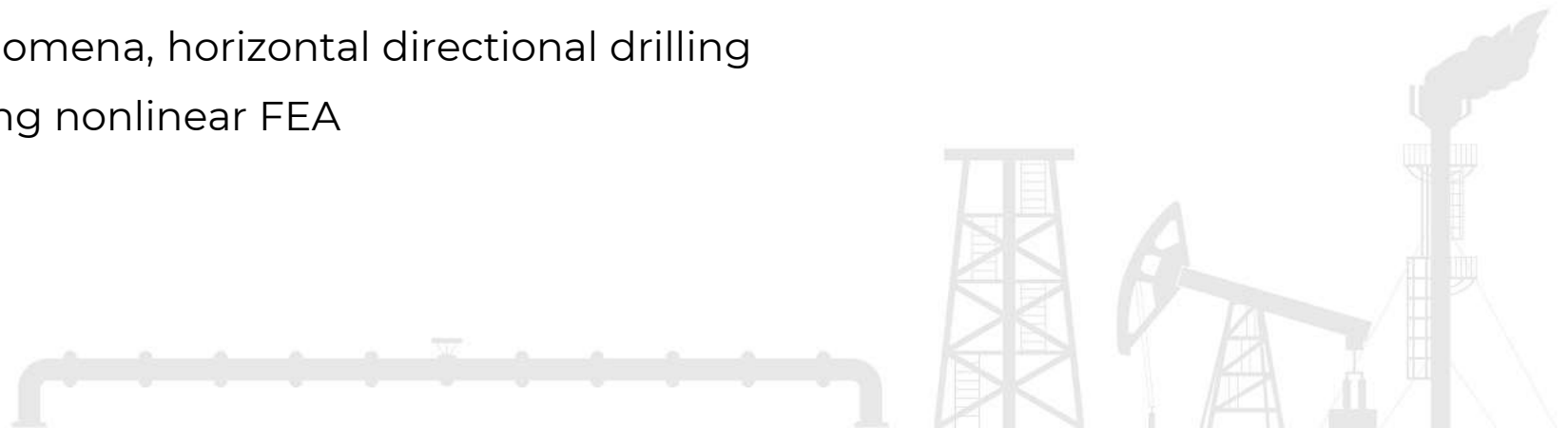
- Quick introduction of PASS/START-PROF
- Supported codes for pipelines
- Underground and aboveground pipeline modeling abilities

## Soil – pipeline interaction and analysis

- Soil model for dry and liquefied soil. Submerged pipelines. Buoyancy
- Soil model for horizontal, inclined, vertical pipelines
- Restrained and unrestrained zones automatic analysis
- Seismic wave propagation analysis
- Soil subsidence, frost heaving, landslide, seismic fault crossing
- Natural arch of collapse phenomena, horizontal directional drilling
- Ring bending calculation using nonlinear FEA



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# Webinar Agenda – Part 2

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## PASS/START-PROF features and usability

- Object-oriented piping model creation principle
- Piping object types: pipe, tees, bends, reducers, etc.
- Equipment objects: Tank Nozzle, Pump, Compressor
- Expansion joint objects
- Databases, wind, ice, snow, seismic loads
- Pipe and fittings wall thickness calculation
- Operation mode editor. Load cases
- Analysis reports: Stress in piping, Stress in insulation, Seismic stress, Flaw stress, Restraint loads, Equipment loads, Displacements, Expansion joints check, variable spring selection, constant spring selection, buckling analysis, flange leakage
- Special features



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Comprehensive pipe stress, flexibility, stability, and fatigue strength analysis with related sizing calculations



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# Quick Pipe Stress Analysis & Optimal Sizing

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- Broad Applicability
- Unsurpassed Usability
- Powerful Capabilities
- Extensive Databases
- Flexible Configurations
- Extensive Code Support
- Widely Used



# PASS/Start-Prof | Broad Applicability

- Process Industry Piping
- Oil and Gas Pipelines
- Utility Network Pipelines
  - District Heating
  - Natural Gas
  - Water
- Power Generation Piping



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# PASS/Start-Prof | Broad Applicability

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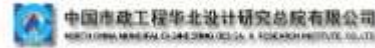
- Developed since 1965
- 2000+ Active users (companies). Licenses 8000+
- User interface and documentation languages: English, Chinese, Russian
- Piping codes: 32
- Wind, Seismic, Snow, Ice codes: 18



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# PASS/Start-Prof | Our Customers



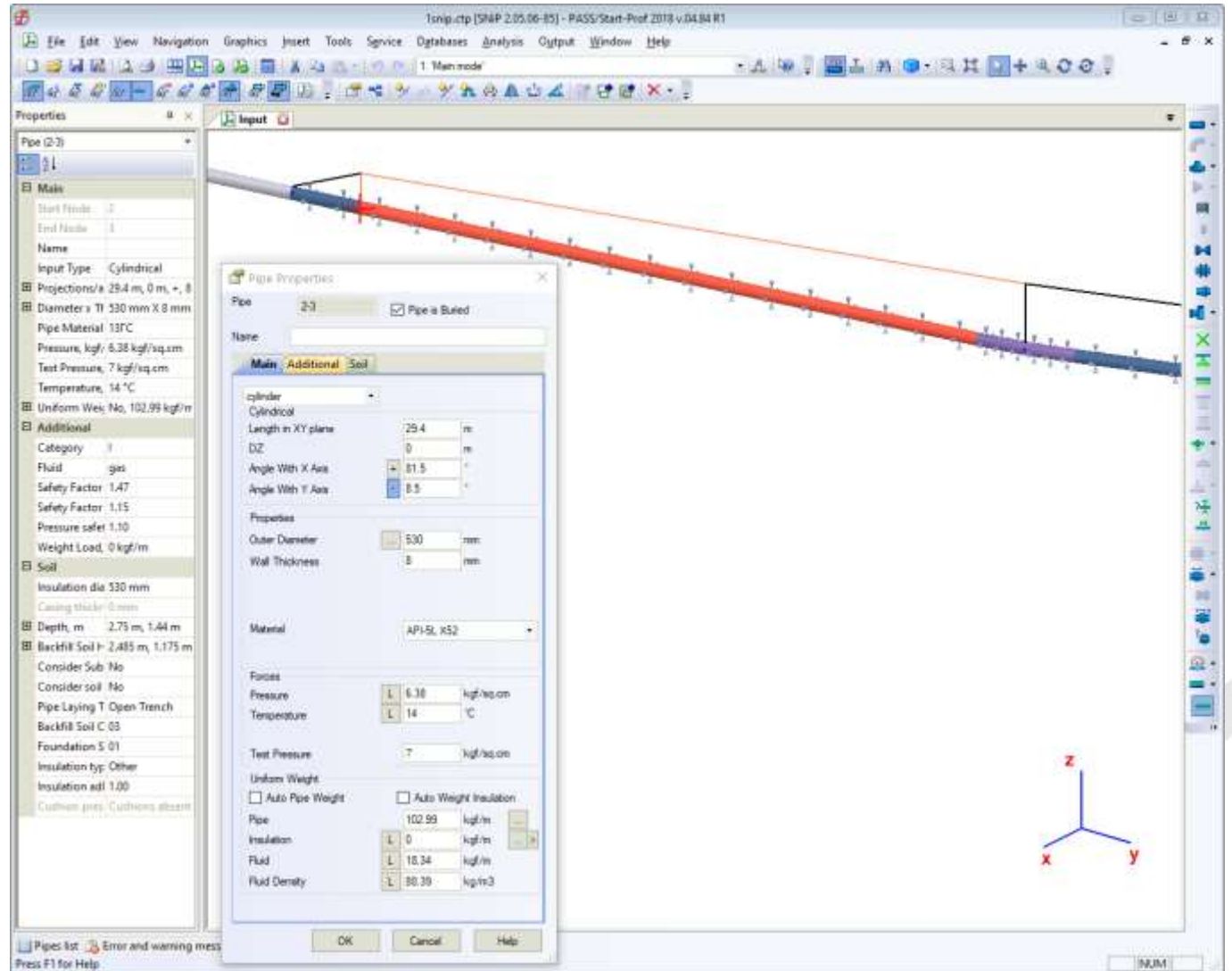
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# PASS/Start-Prof | Features

- Increase your Productivity and Save your Time
- Save your Money (we have a friendly pricing policy)
- Increase the Accuracy of Pipe Stress Analysis



# PASS/Start-Prof | Features

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- First hand quick response from experienced piping engineers in UK, China, Mexico, Brazil, Australia, Egypt, Turkey and others
- Direct support from developers via e-mail is available
- Easy to learn, fast and simple to work with for a new pipe stress analyst
- Due to intuitive modern object-oriented user interface, you can start working immediately. Companies can put PASS/START-PROF into application immediately after purchase, significantly reducing costs and save the time without compromising on the quality of end results



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# PASS/Start-Prof | Features

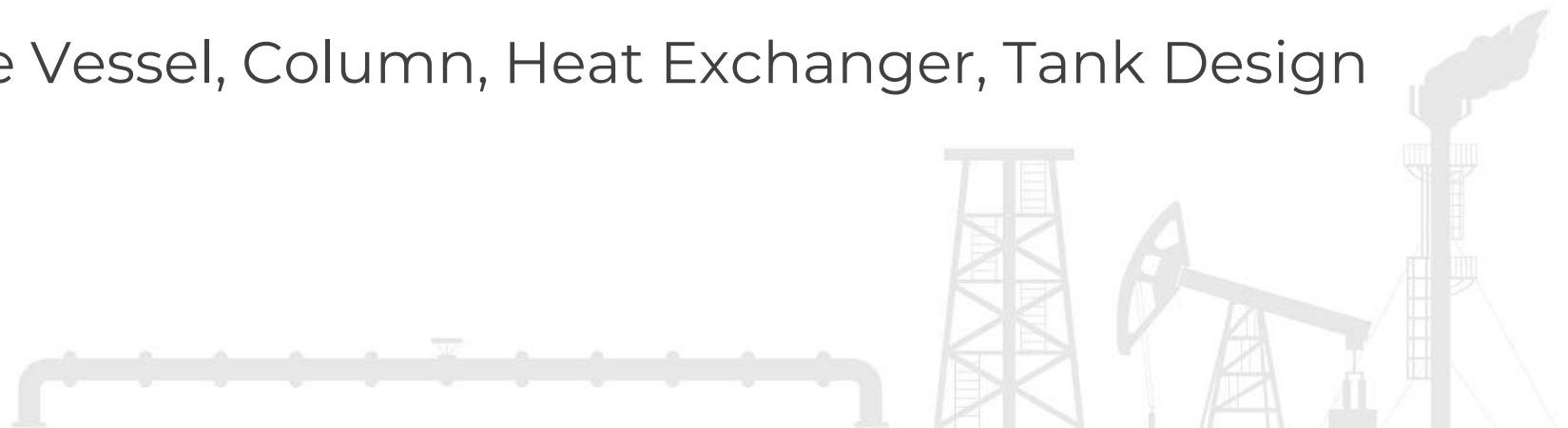
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PASS/START-PROF is a part of PASS Suite:

- **PASS/START-PROF** – Pipe Stress Analysis Software
- **PASS/HYDROSYSTEM** – Piping hydraulic and Thermal Analysis Software
- **PASS/ NOZZLE-FEM** – Nozzle to Shell Junction Finite Element Analysis Software. Calculate SIF, k-factors, Nozzle Flexibility and Stress Analysis, etc.
- **PASS/EQUIP** – Pressure Vessel, Column, Heat Exchanger, Tank Design and Analysis Software



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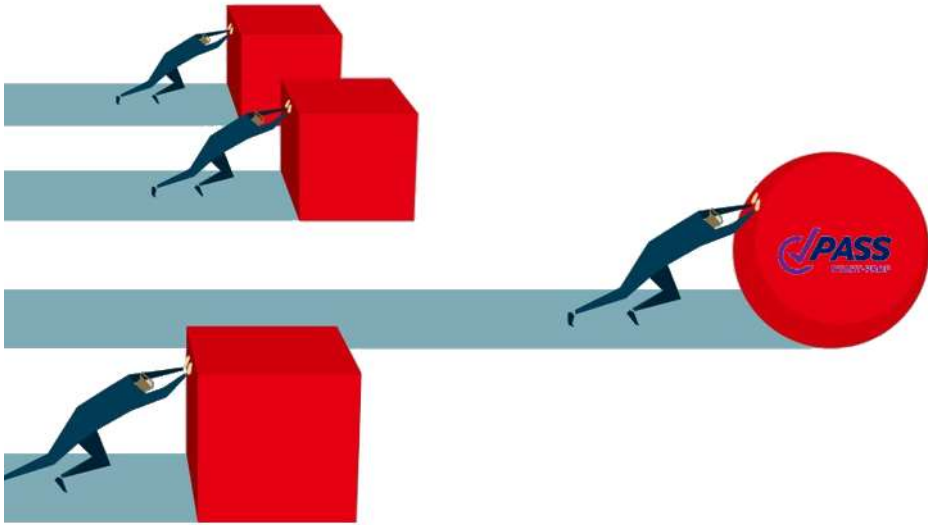


# PASS/Start-Prof | Increase Productivity

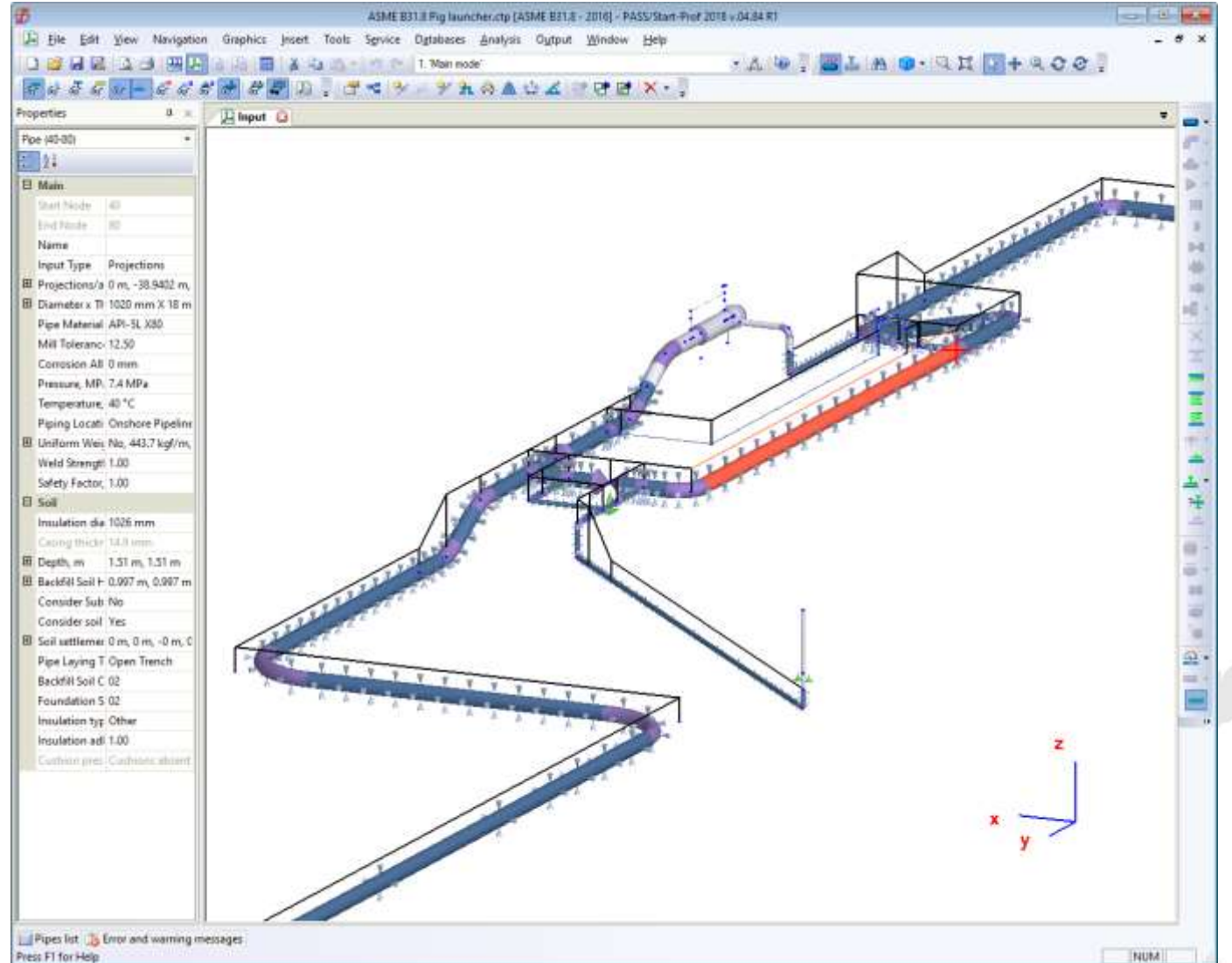
PASS/START-PROF is a Professional Modern Pipe Stress Analysis Software

PASS/START-PROF Makes Complex Things Simple

You will Get the Same Result, but Faster and Easier

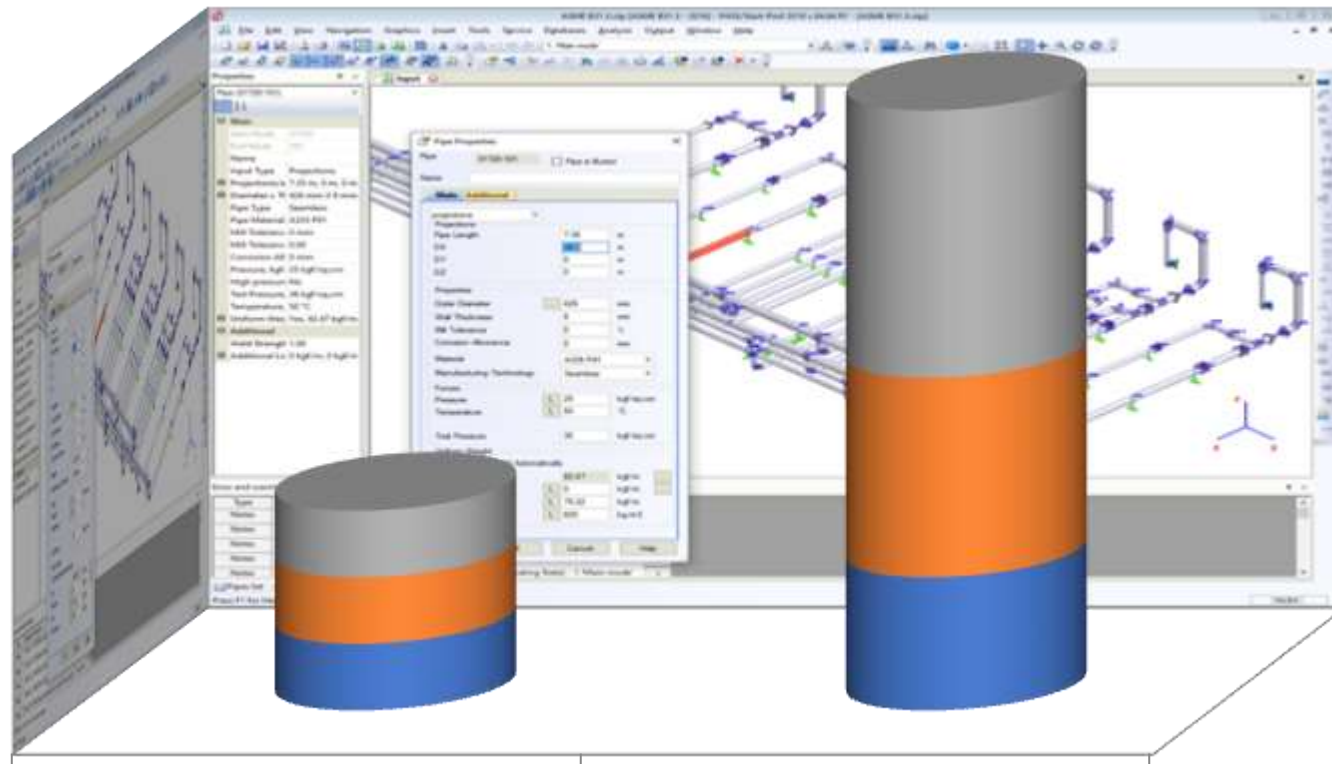


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Pipe (40-00)	
Start Node	40
End Node	80
Name	
Input Type	Projections
Projections/a	0 m, -38.9402 m,
Diameter x Th	1020 mm X 18 m
Pipe Material	API-5L X80
Mill Toleranc	12.50
Corrosion All	0 mm
Pressure, MPa	7.4 MPa
Temperature	40 °C
Piping Locati	Onshore Pipeline
Uniform Weis	No, 443.7 kgf/m,
Weld Strength	1.00
Safety Factor	1.00
Soil	
Insulation dia	1026 mm
Casing thick	14.0 mm
Depth, m	1.51 m, 1.51 m
Backfill Soil	± 0.007 m, 0.007 m
Consider Sub	No
Consider soil	Yes
Soil settleme	0 m, 0 m, -0 m, 0
Pipe Laying T	Open Trench
Backfill Soil	C 02
Foundation S	02
Insulation ty	Other
Insulation ad	1.00
Coef heat pres	Conductive absent

# PASS/Start-Prof | How START-PROF Saves your Time



START-PROF

Other Pipe Stress  
Software

- Time to Create the Model
- Time to Analyze and Optimize the Model
- Time to Create the Report



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# PASS/Start-Prof | Supported Codes

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PASS/START-PROF can analyze piping according to 32 piping codes.  
The software contains all needed and latest codes for pipelines analysis:

- ASME B31.4 + Ch. IX, Ch. XI
- ASME B31.8 + Ch. VIII
- ASME B31.12
- CSA Z662-19 + Ch.11
- BS PD 8010-1
- BS PD 8010-2
- GB 50251
- GB 50253
- SNIP 2.05.06-85
- SP 36.13330.2012
- GOST P 55989
- GOST P 55990
- SP 284.1325800
- SP 33.13330



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# PASS/Start-Prof | Analysis Capabilities

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PASS/START-PROF has professional analysis abilities needed for Process and Power Piping Stress Analysis:

- Nonlinear analysis of gaps, friction, one-way restraints, rotating rods, etc.
- Special algorithm that improves the nonlinear model convergence on-the-fly without manual tuning (gaps and one-way restraints cycling, friction force cycling etc.). We receive from users the models that didn't converge, put it into our collection and continuously improve that algorithm for past 55 years. It allow to achieve convergence in 99.9% models
- Nozzle, tee, bend flexibilities and SIF (Code, ASME B31J, WRC 537/297, PD 5500, FEA)
- Nozzle, pump and other equipment automatic checks (API, ISO, NEMA standards)
- Optimal automatic variable and constant spring selection using manufacturers catalogue

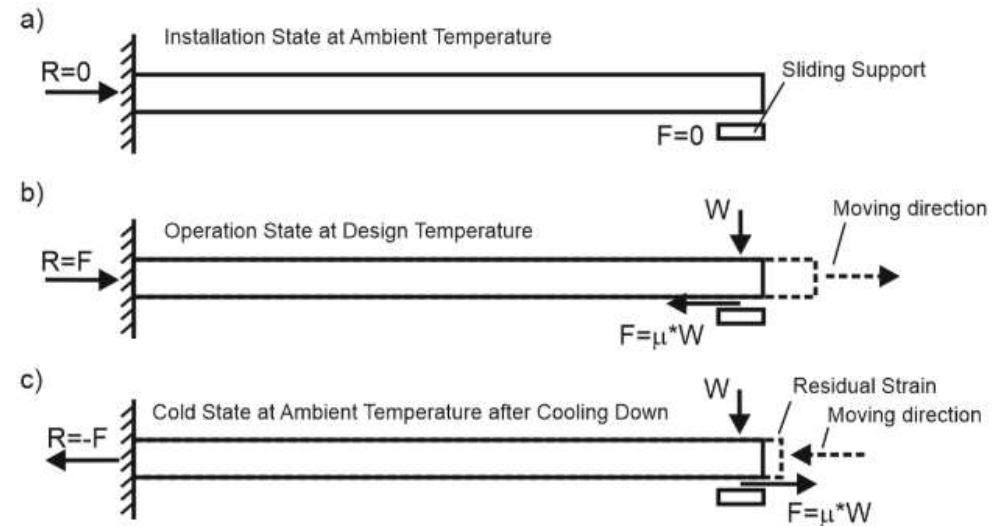
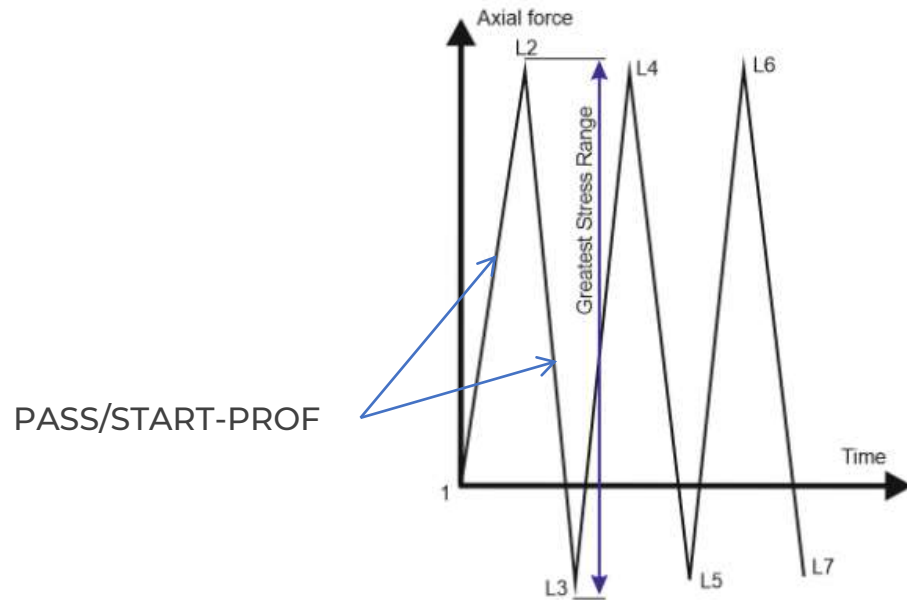


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# PASS/Start-Prof | Analysis Capabilities

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



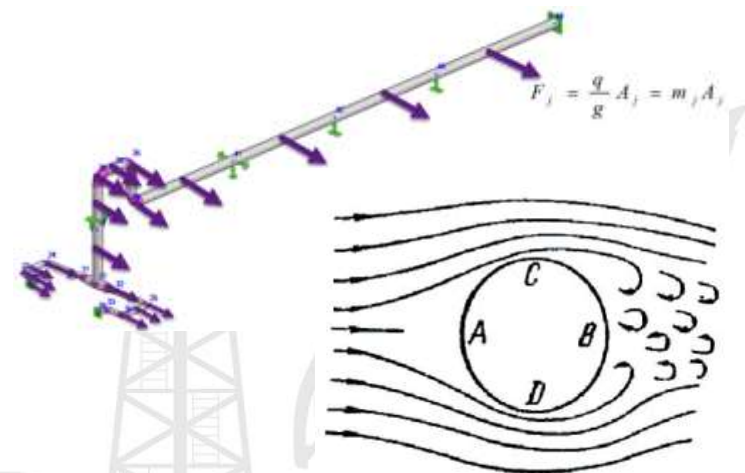
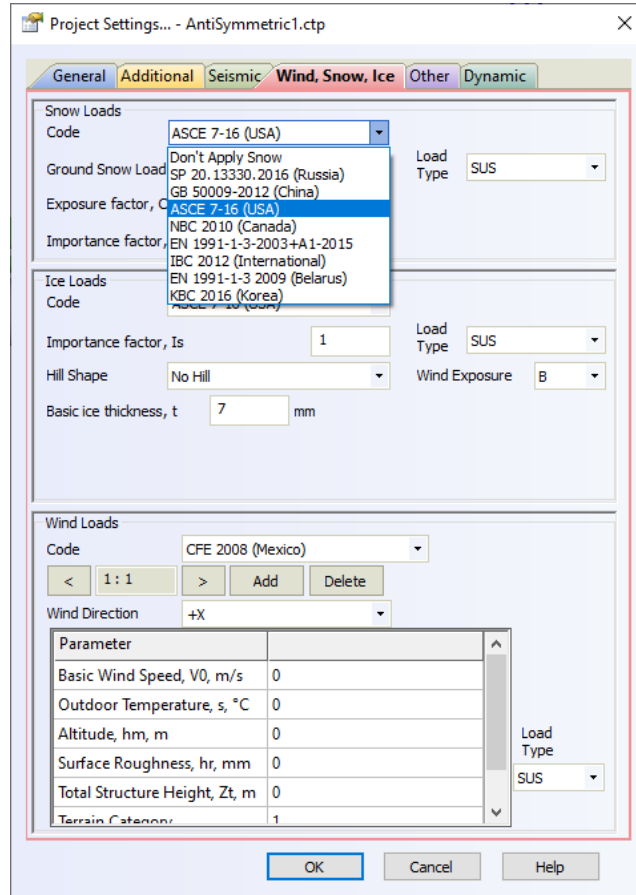
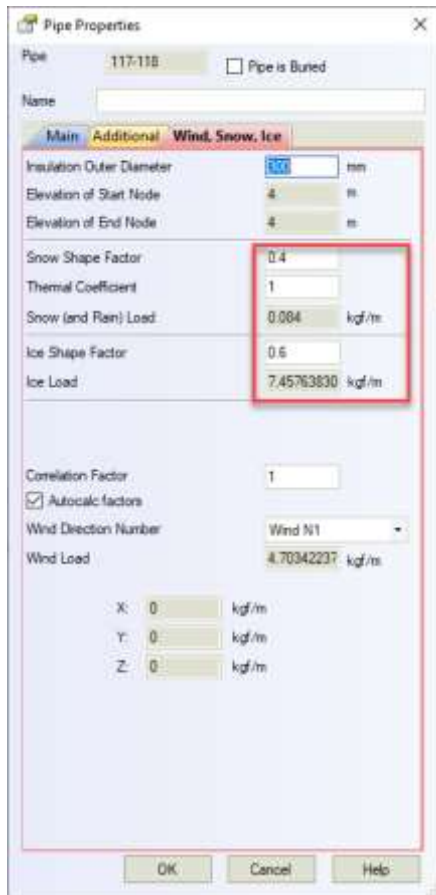
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# PASS/Start-Prof | Analysis Capabilities

Automatic generation of a wind, snow, ice, seismic loads according to 18 national codes

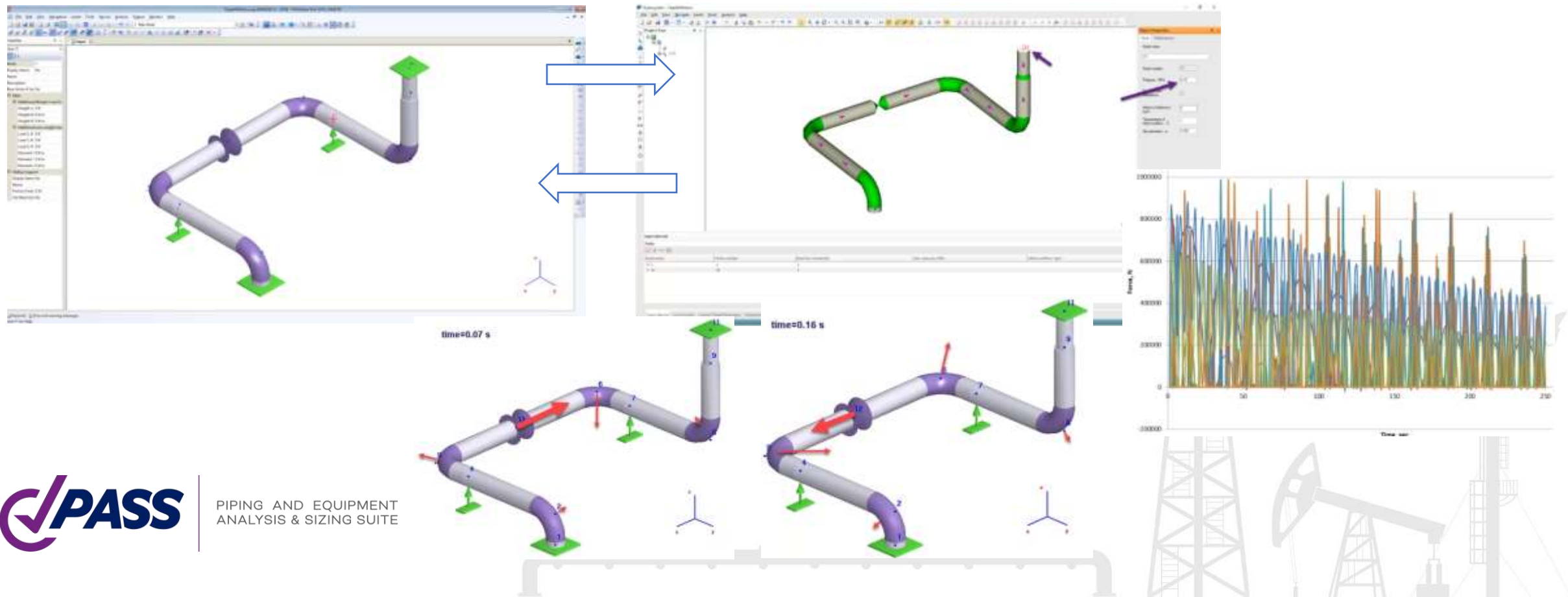


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# PASS/Start-Prof | Analysis Capabilities

PASS/START-PROF + PASS/HYDROSYSTEM Allows to Water Hammer Surge Analysis

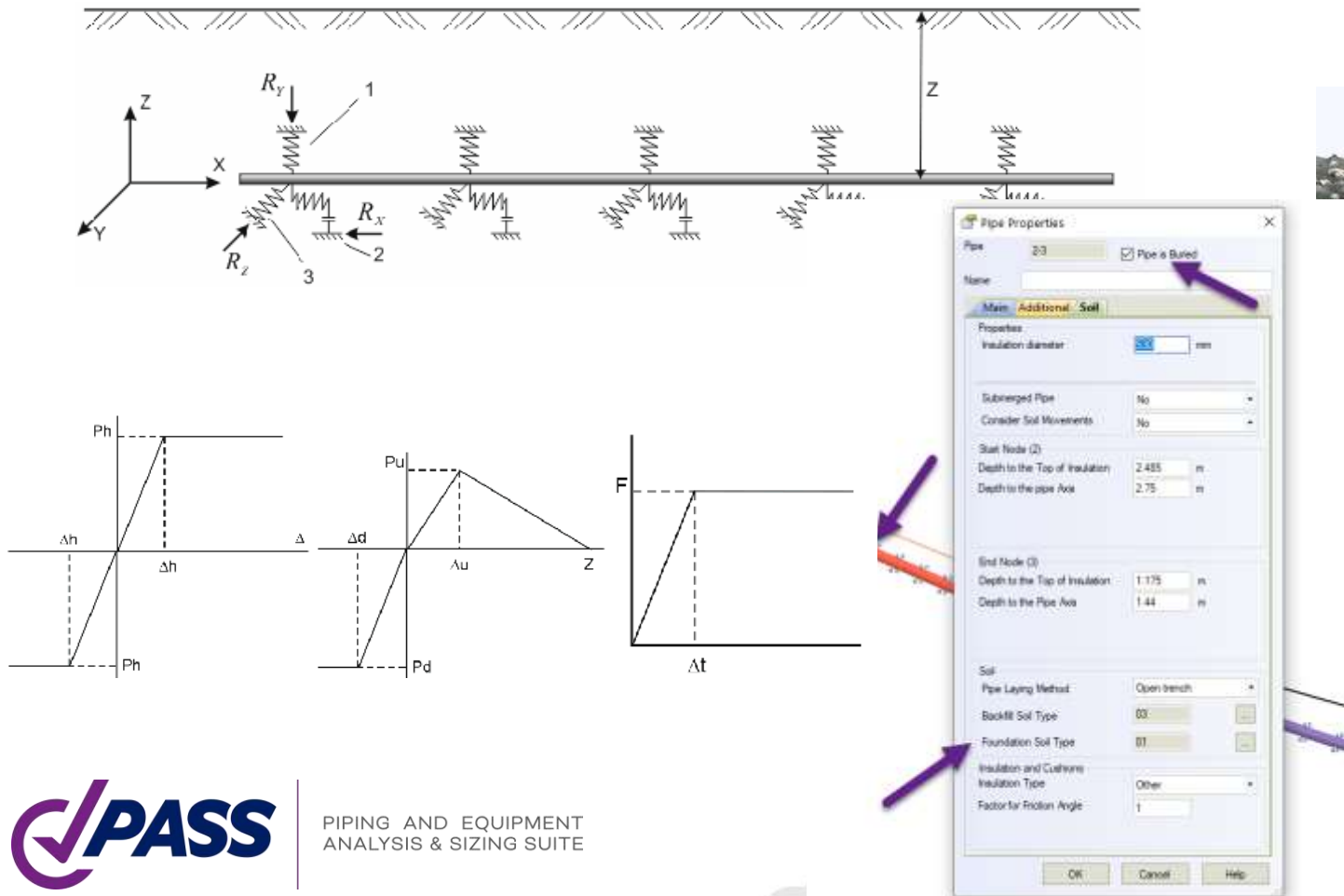
- 3D piping Models converted automatically from START-PROF to HYDROSYSTEM and back
- 3D loading is converted simultaneously for all nodes in the system at the same moment of time



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# PASS/Start-Prof | Dry Soil 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



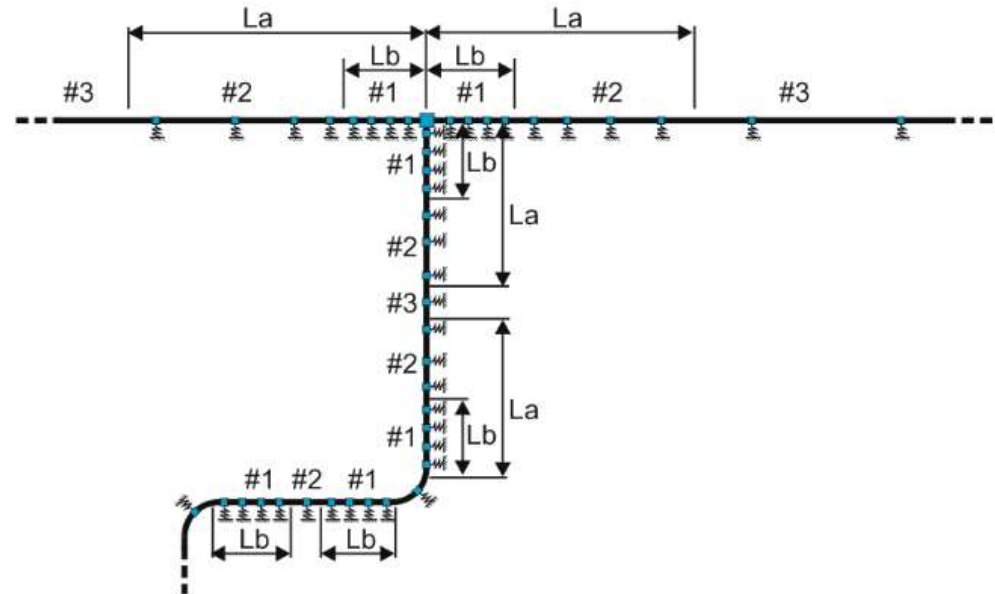
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# PASS/Start-Prof | Dry Soil Model

**Zone #1:** Lateral bearing zone (unrestrained) with the length of  $L_b$ . Four supports are placed at equal distance

**Zone #2:** Axial sliding zone (unrestrained) with the length of  $L_a$ . Four supports are placed at a distance increasing exponentially from zone #1 to zone #3

**Zone #3:** Restrained zone. Supports are placed at  $100D$  spacing, where  $D$  - pipe external diameter



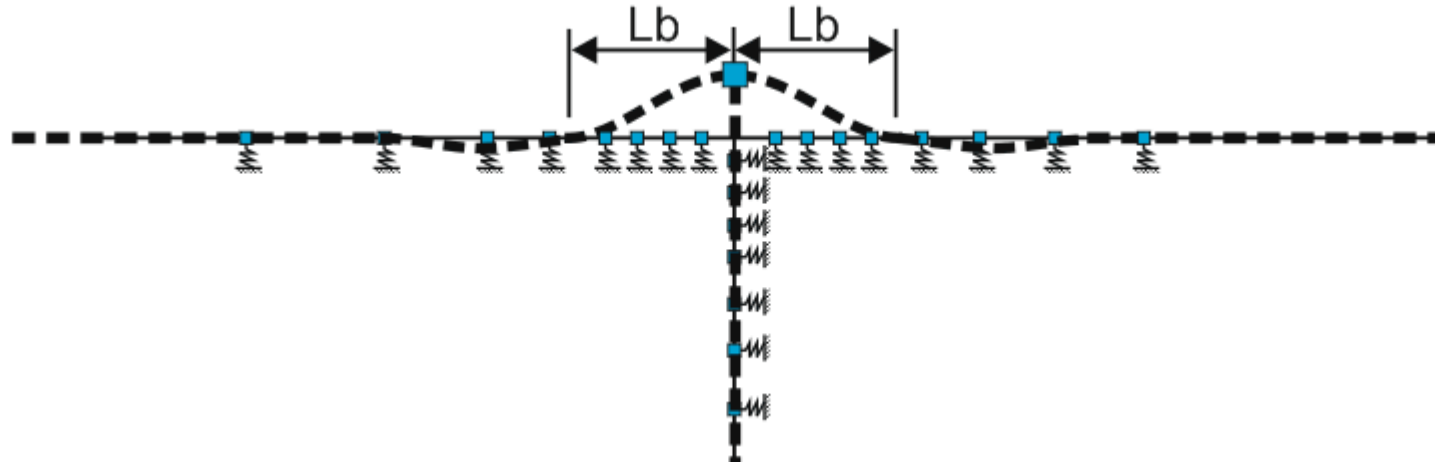
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# PASS/Start-Prof | Dry Soil Model

Zone #1: Lateral bearing zone (unrestrained) with the length of  $L_b$ . Four supports are placed at equal distance

$$L_b = \frac{3\pi}{4} \sqrt[4]{\frac{4EI}{k}}$$

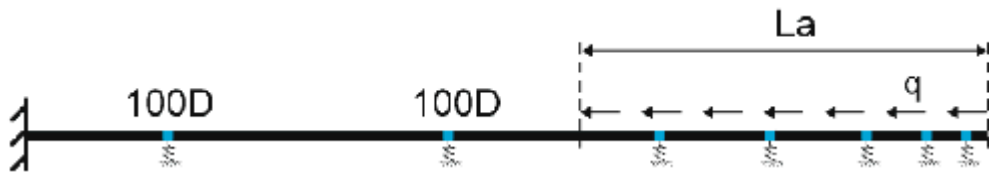


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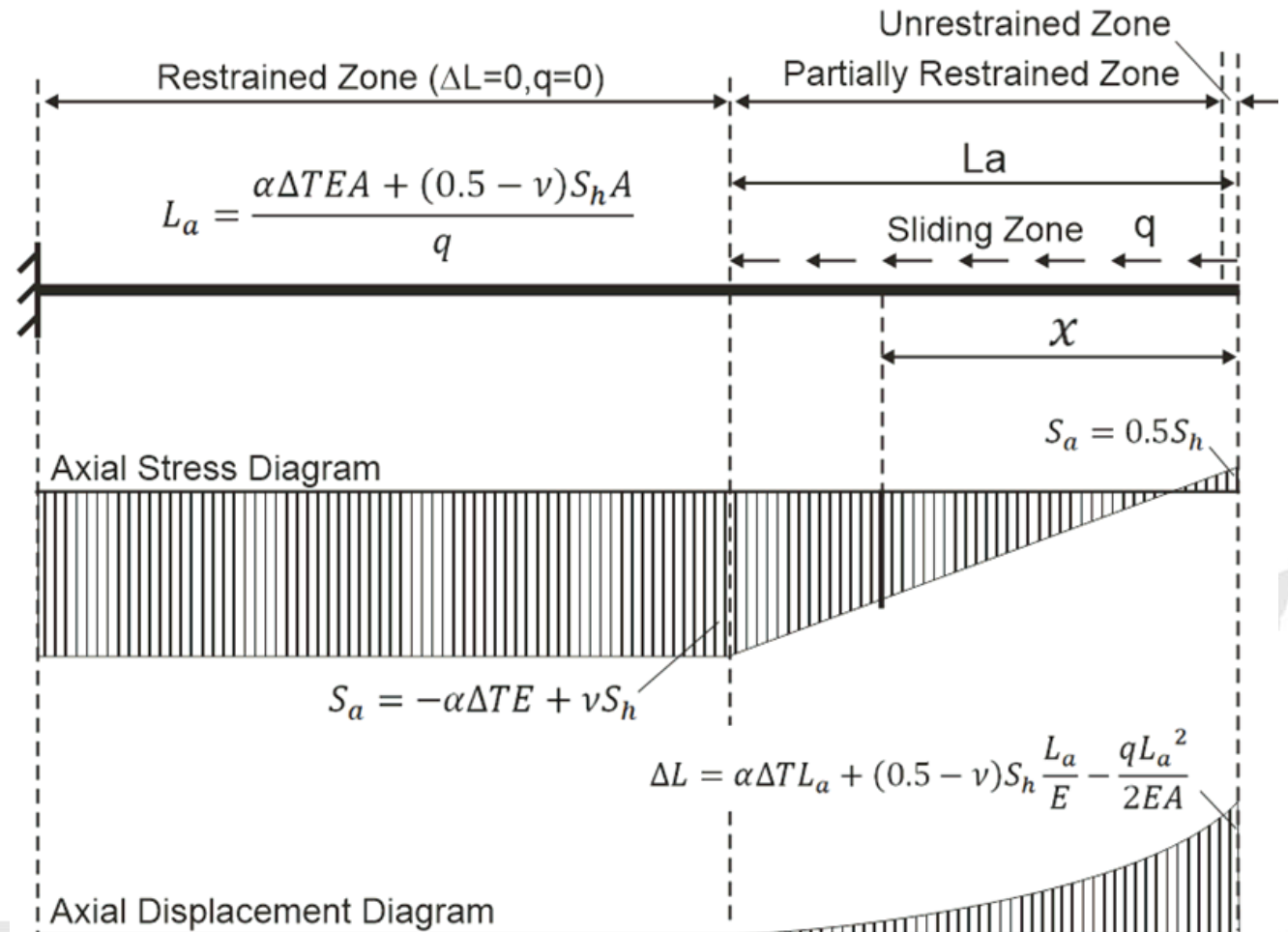


# PASS/Start-Prof | Dry Soil Model

Zone #2: Axial sliding zone (unrestrained) with the length of  $L_a$ . Four supports are placed at a distance increasing exponentially from zone #1 to zone #3

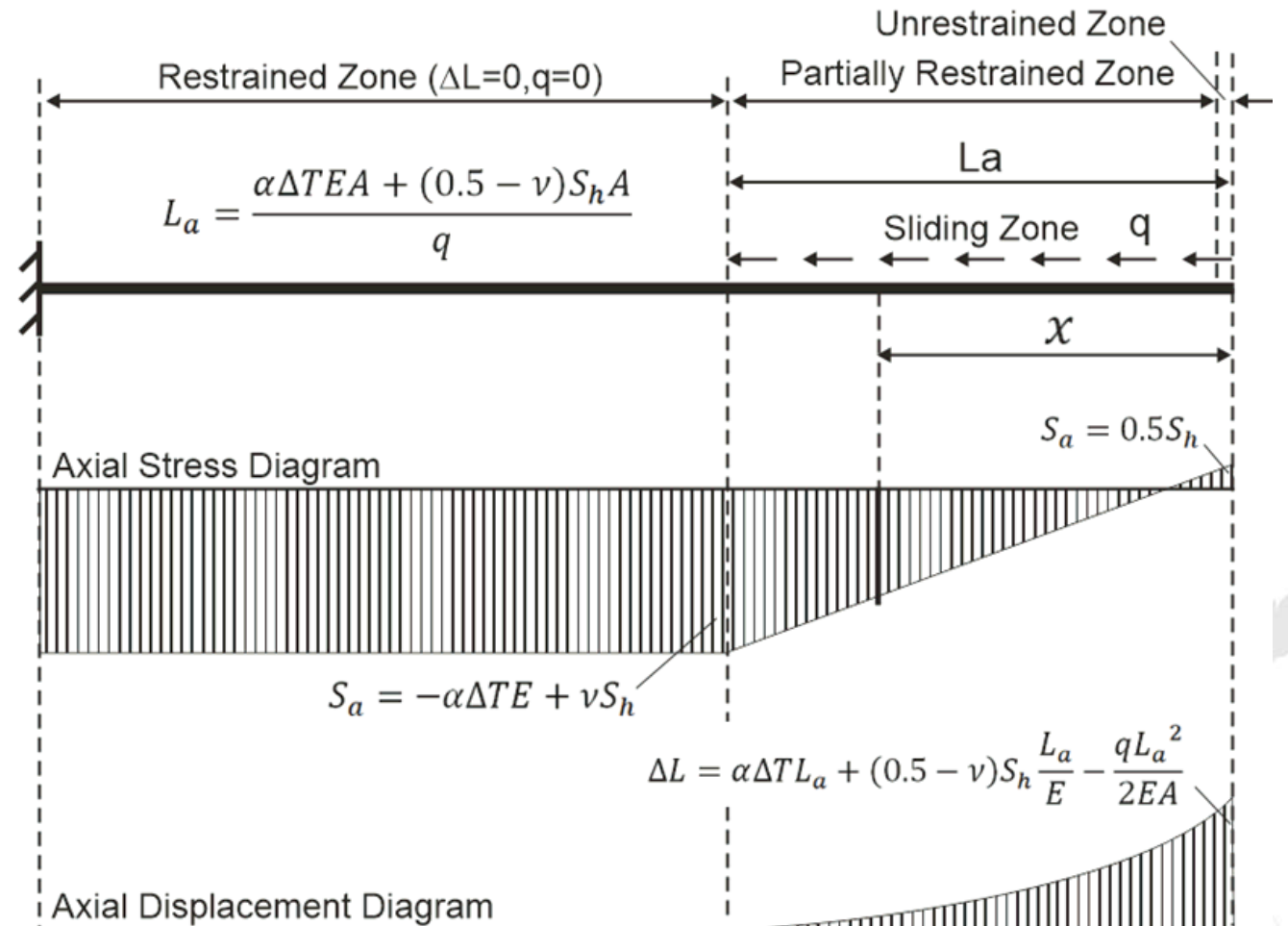
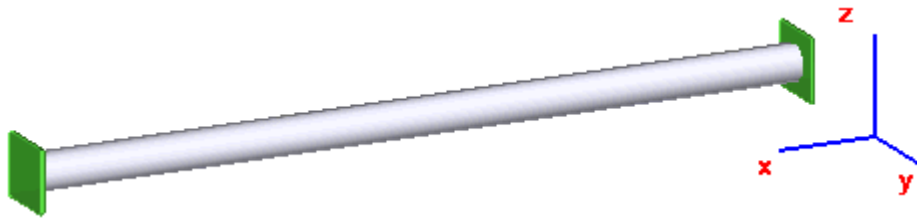


$$L_a = \frac{\alpha \Delta T E A + (0.5 - \nu) S_h A}{q} + 3 \sqrt{\frac{E A}{\pi D C_{x0}}}$$

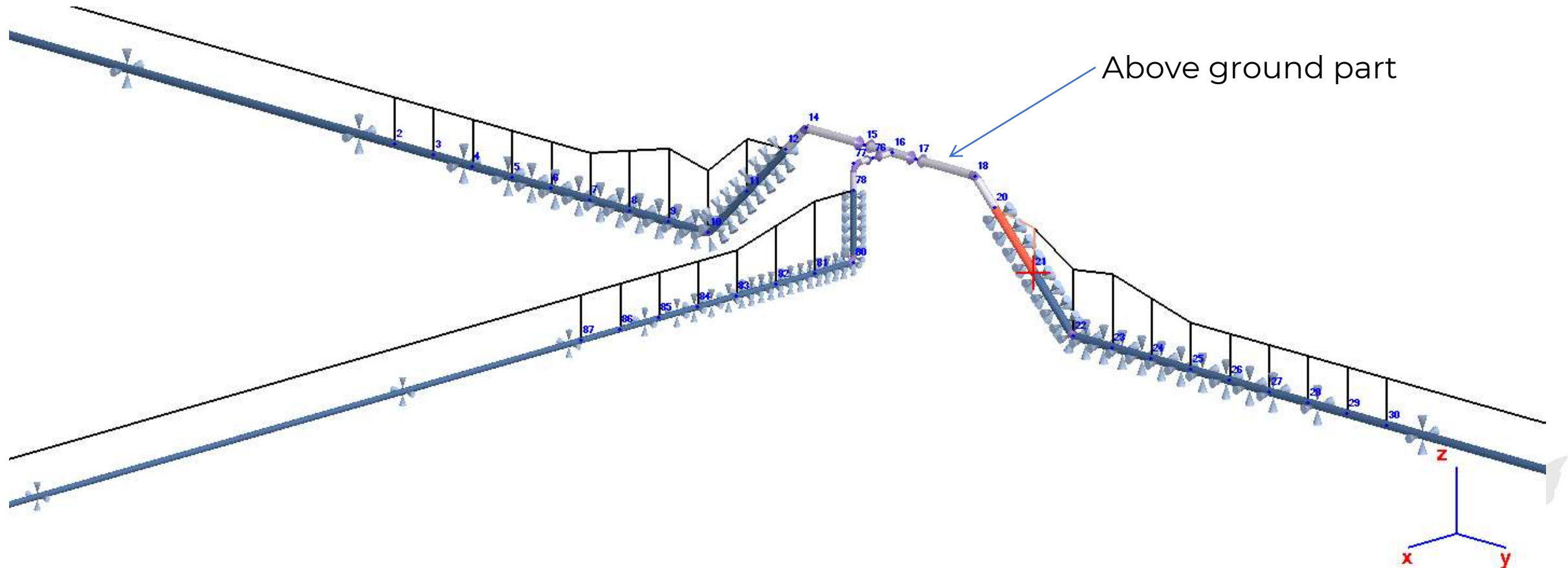


# PASS/Start-Prof | Dry Soil Model

Zone #3: Restrained zone. Supports are placed at 100D spacing, where D - pipe external diameter



# PASS/Start-Prof | Dry Soil Model

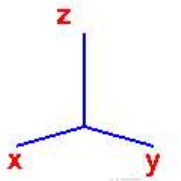
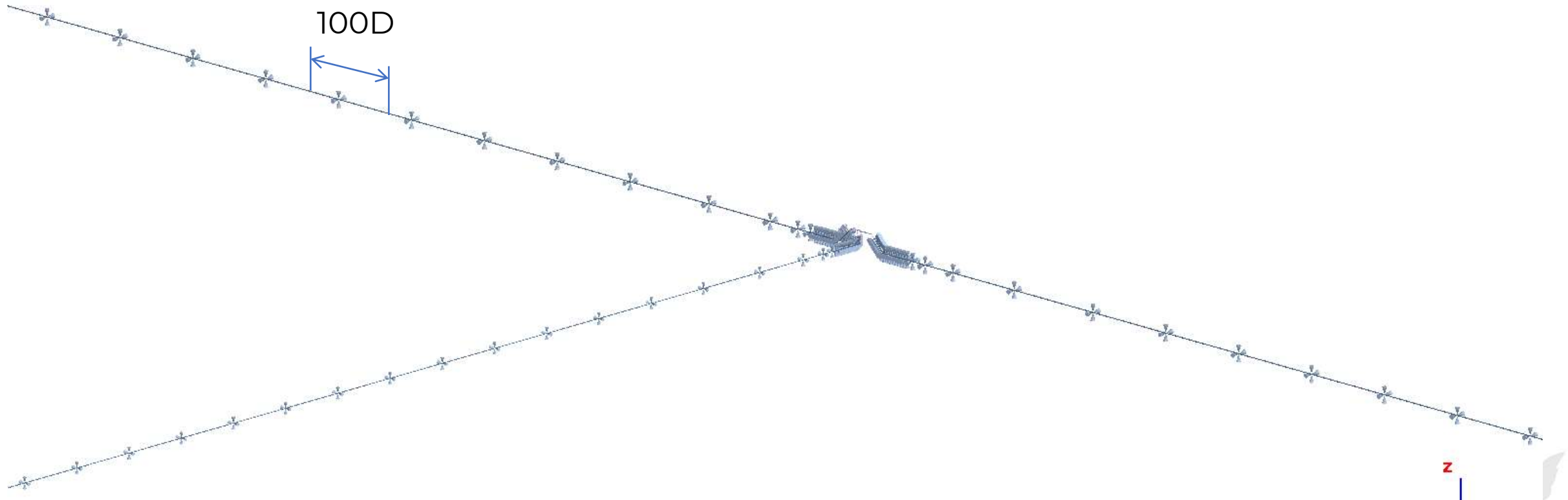


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# PASS/Start-Prof | Dry Soil Model

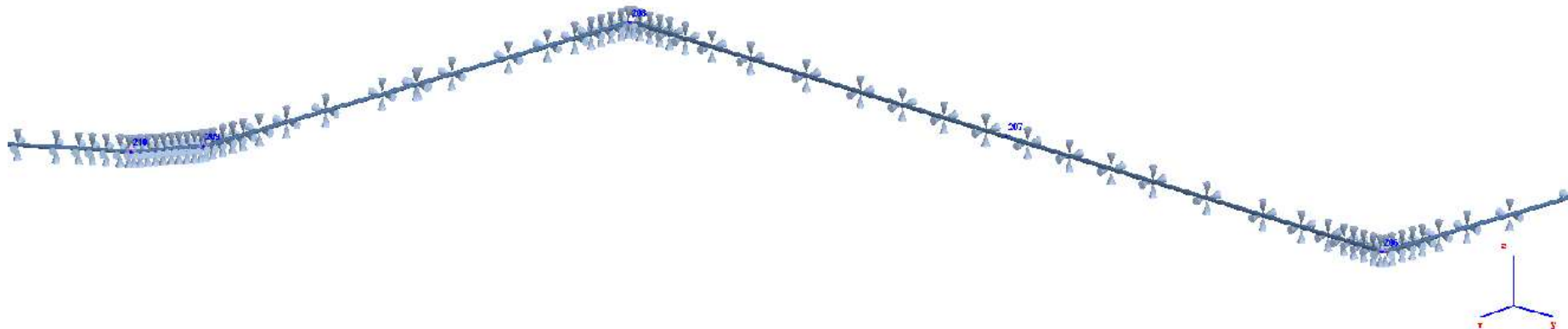
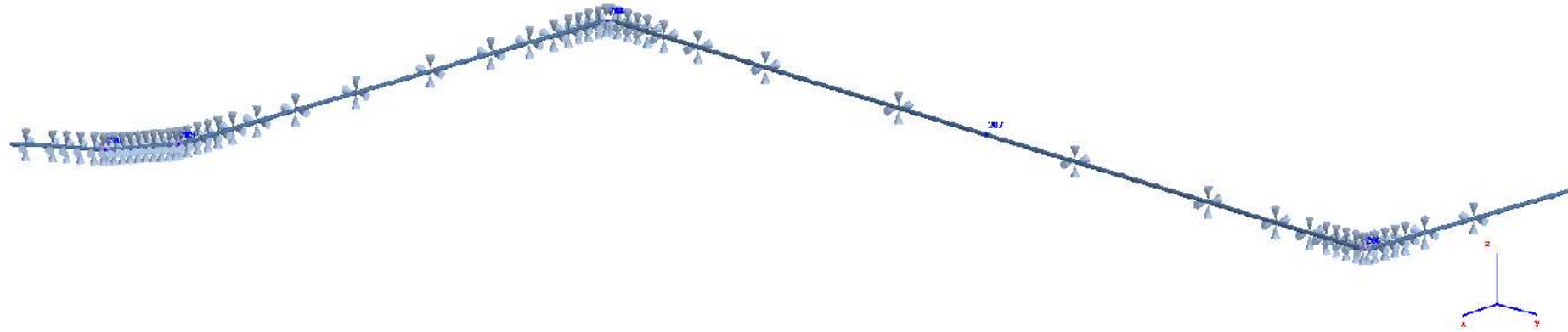


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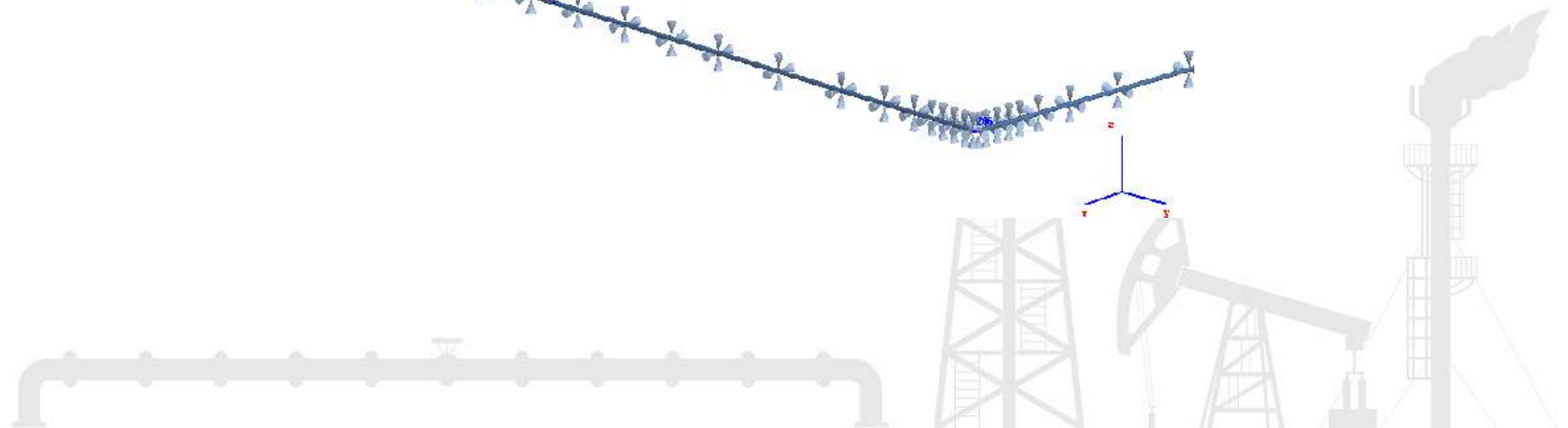


# PASS/Start-Prof | Dry Soil Model

It is possible to manually increase the condensation of soil springs to increase the result accuracy:



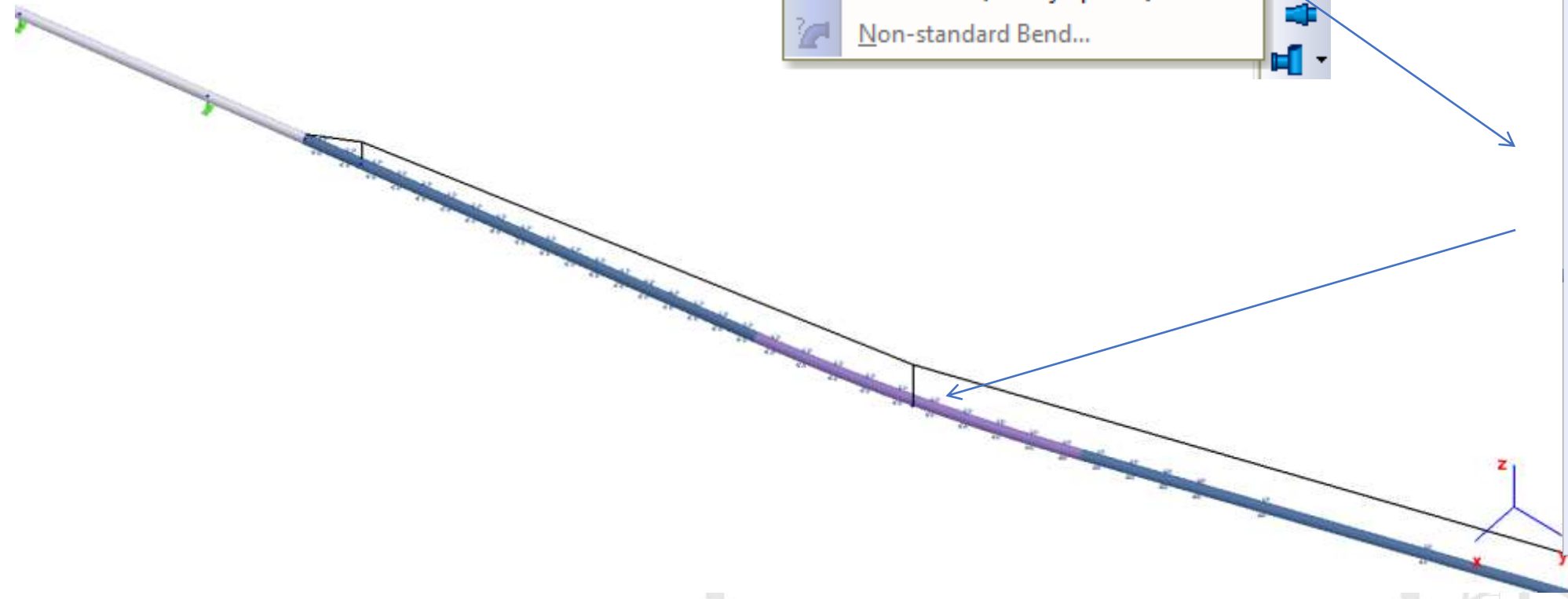
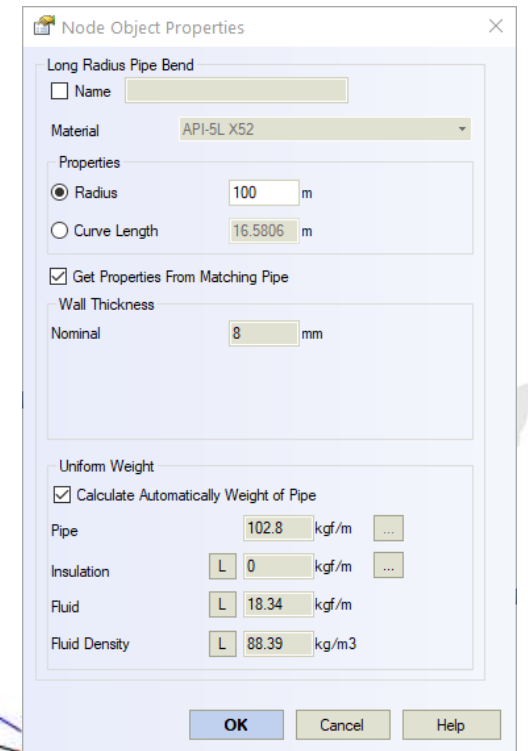
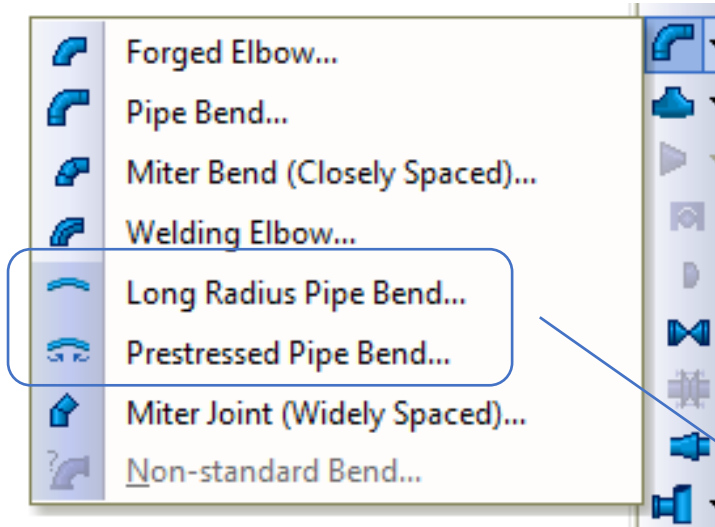
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# PASS/Start-Prof | Dry Soil Model

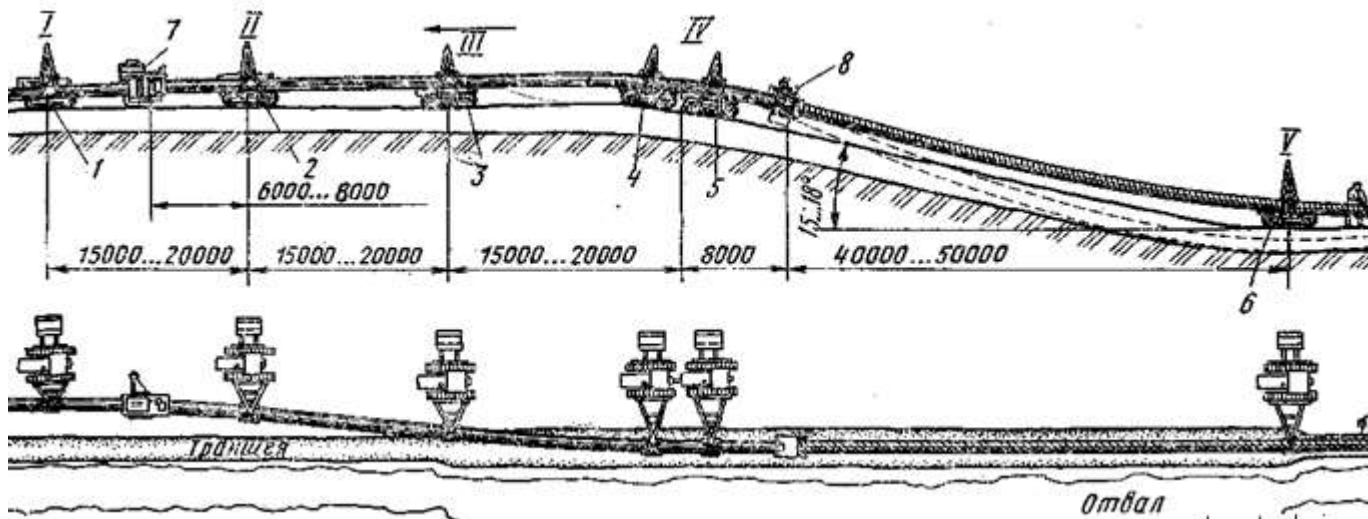
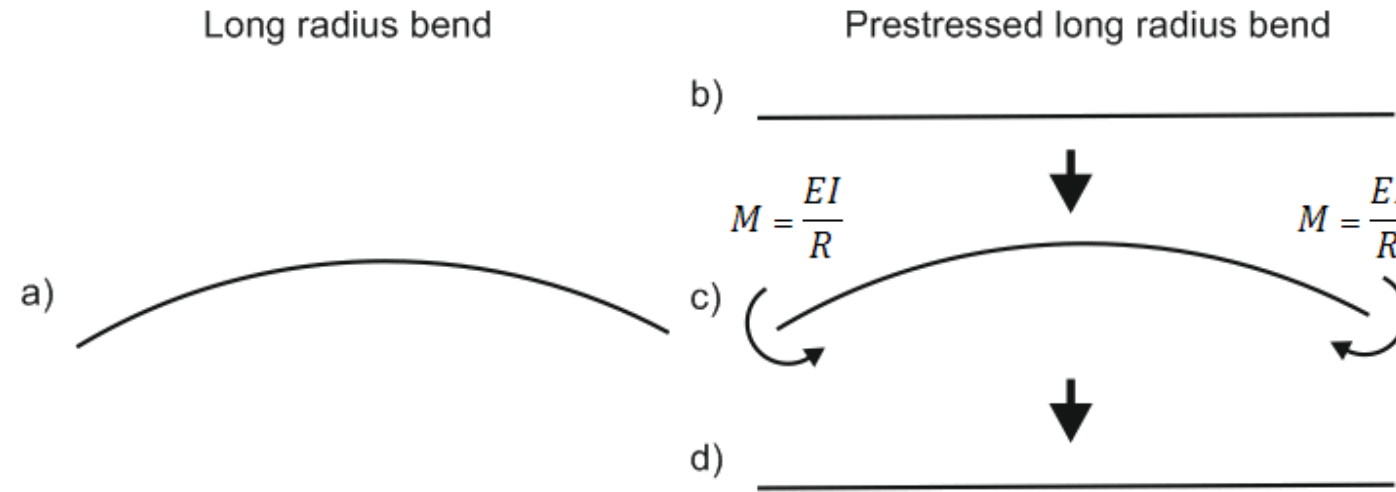
Two Long Radius Bend Objects:

- Long radius pipe bend
- Prestressed pipe bend



# PASS/Start-Prof | Dry Soil Model

Prestressed pipe bend – Initial elastic bend curvature in vertical and horizontal plane

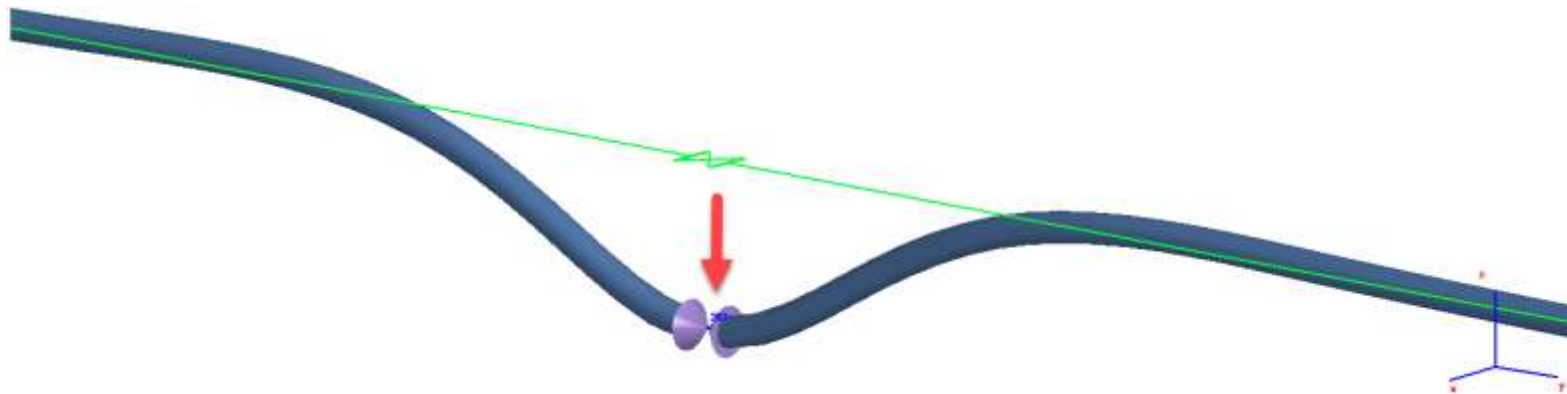


# PASS/Start-Prof | Dry Soil Model

The weight of pipeline, insulation and product is automatically removed to avoid the huge deflections in 100D pipe spans (zone #3).

This the sum of pipeline, insulation, and product weights is used to calculate the soil springs properties including the friction force.

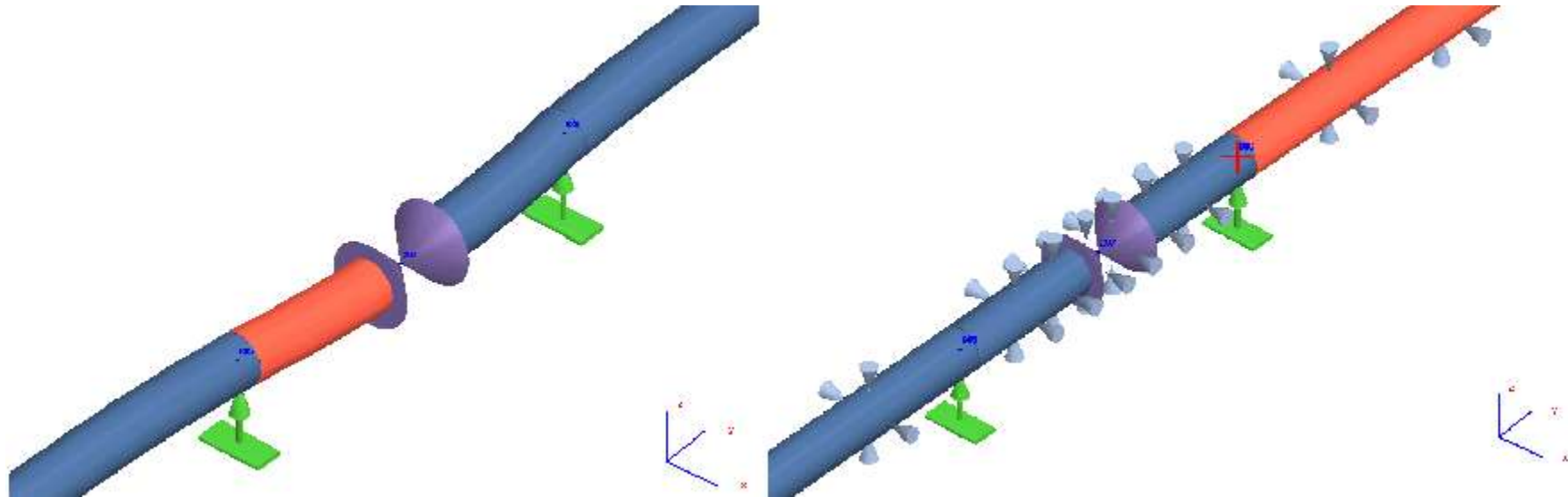
But if you will add the heavy valve on buried pipeline, the weight of the valve will be considered and you will see the deflections:



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# PASS/Start-Prof | Dry Soil Model

Also you can add the buried supports. It doesn't affect the accuracy of the soil model:

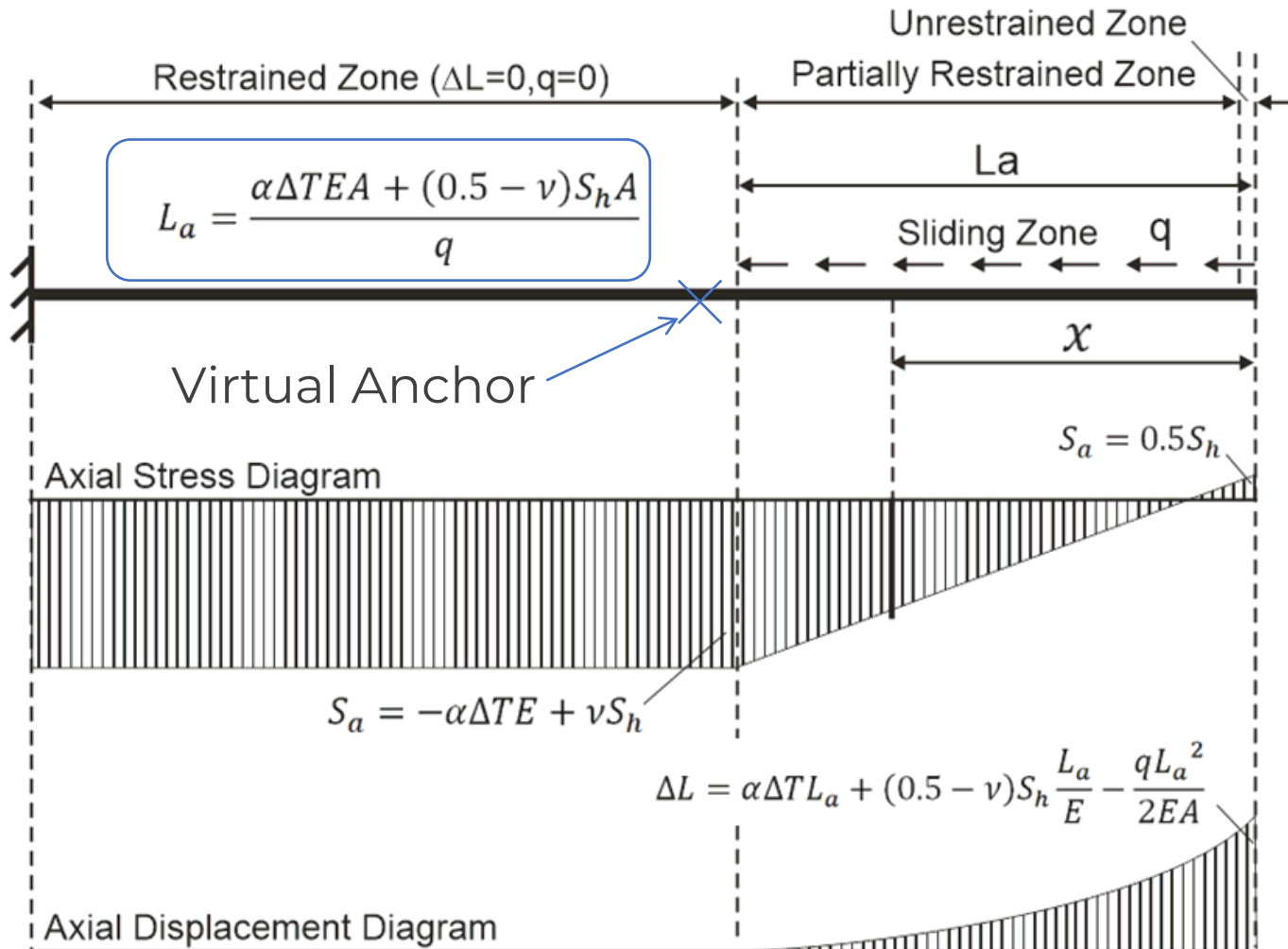


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# PASS/Start-Prof | Dry Soil Model

ASME B31.4, B31.8, CSA Z662, B31.12PL, BS PD 8010 codes divide pipes into Restrained and Unrestrained



Unrestrained (ASME B31.4)

$$S_L = \frac{PD}{4t} \pm \frac{iM}{A} + \frac{F_a}{A} \leq 0.75 S_y$$

Restrained (ASME B31.4)

$$S_L = S_E + \nu S_H \pm \frac{M}{A} + \frac{F_a}{A} \leq 0.9 S_y$$

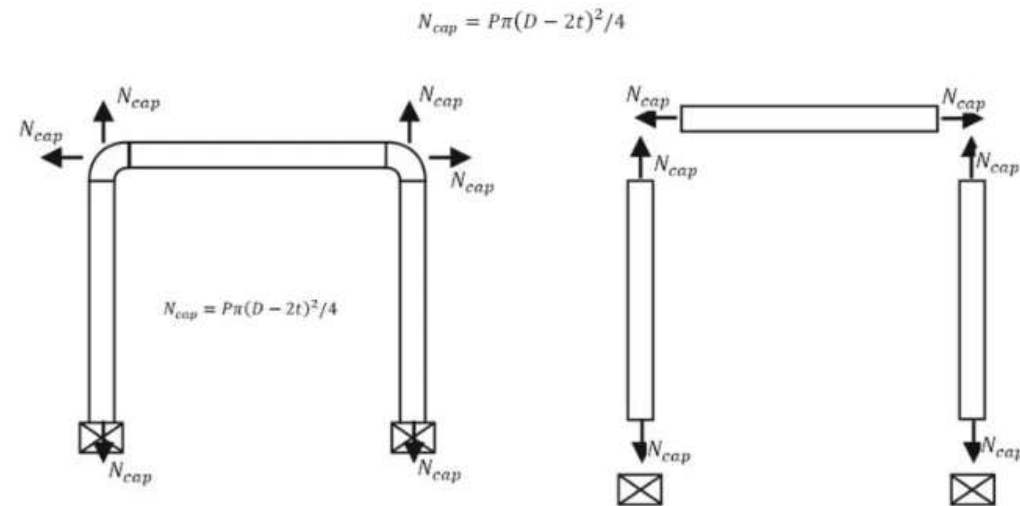
$$S_{eq} \leq 0.9 S_y$$

Partially Restrained Zone?  
How to Check Stress???

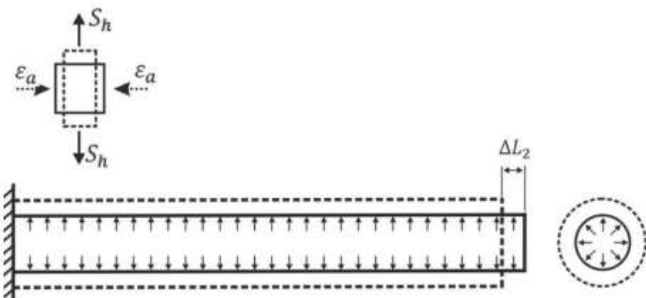
# PASS/Start-Prof | Dry Soil Model

Bourdon Effect in PASS/START-PROF:

1) Pressure thrust forces applies at the ends of each pipe



2) Pipe shortening due to pressure load added



$$\epsilon_a = -2\nu \frac{P}{E} \frac{(D - 2t)^2}{D^2 - (D - 2t)^2}$$

$$\Delta L = \alpha \Delta T L - 2\nu \frac{PL}{E} \frac{(D - 2t)^2}{D^2 - (D - 2t)^2} \approx \alpha \Delta T L - \nu S_h \frac{L}{E}$$





# PASS/Start-Prof | Dry Soil Model

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If you have the pipeline with zero thermal expansions, you will still get the support loads and displacements caused by pressure Bourdon effect!

Bourdon effect is always activated in PASS/START-PROF to avoid human mistakes when users forget to activate it. It is non-disabling function!

It changes results significantly for:

- High pressure piping and pipelines
- Plastic piping (PE, PP, PB, PVC)
- FRP/GRP/GRE piping



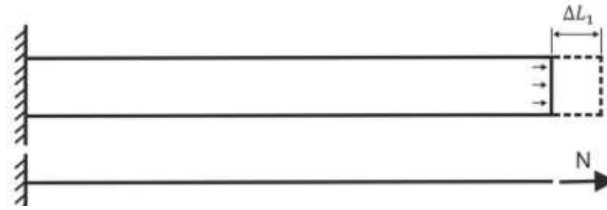
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# PASS/Start-Prof | Dry Soil Model

## Unrestrained Pipe

$$\Delta L = \alpha \Delta T L + (1 - 2\nu) \frac{PL}{E} \frac{(D - 2t)^2}{D^2 - (D - 2t)^2} \approx \alpha \Delta T L + (0.5 - \nu) S_h \frac{L}{E}$$



$$S_a = \frac{N}{A} = P \frac{(D - 2t)^2}{D^2 - (D - 2t)^2} \approx 0.5 S_h$$

$$S_a = P \frac{(D - 2t)^2}{D^2 - (D - 2t)^2} \approx \frac{P(D - t)}{4t} \approx \frac{PD}{4t}$$

$$S_a = \frac{PD}{4t} + \frac{M}{Z} + \frac{N}{A} \leq S_{Allow}$$

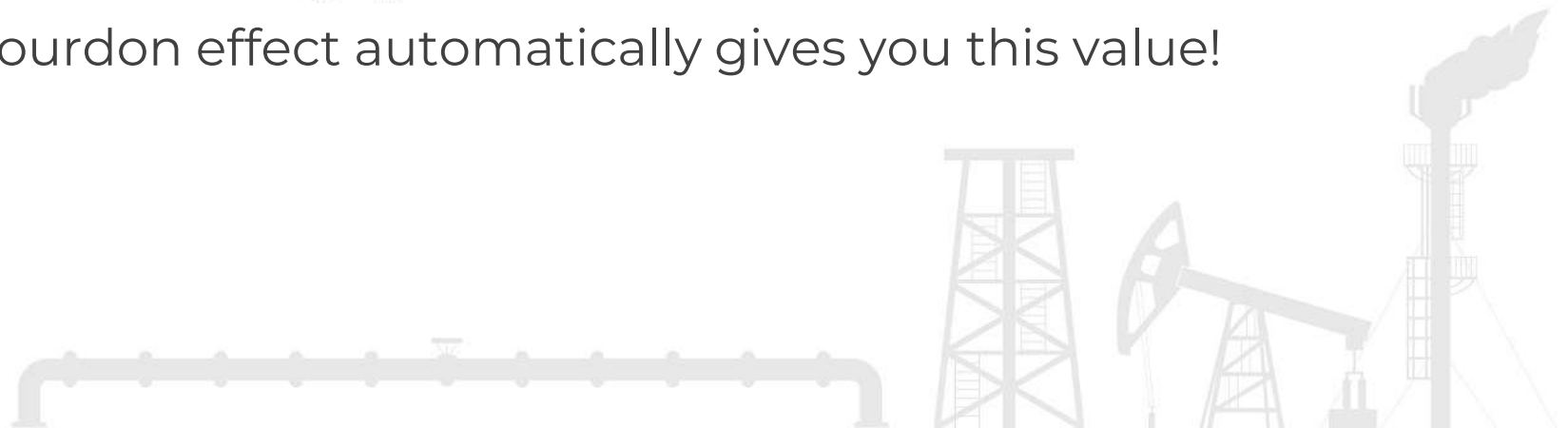
If axial force already contain pressure thrust force (Bourdon effect), then stress check can be done by the following equation:

$$S_a = \frac{M}{Z} + \frac{N}{A} \leq S_{Allow}$$

PD/4t should be removed. Bourdon effect automatically gives you this value!



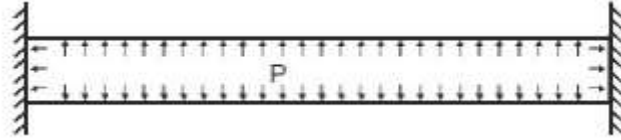
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# PASS/Start-Prof | Dry Soil Model

## Restrained Pipe

$$N = -\alpha\Delta TEA + 2v \frac{\pi P(D - 2t)^2}{4} \approx -\alpha\Delta TEA + vS_h \cdot A$$



$$S_a = \frac{N}{A} = -\alpha\Delta TE + 2v \frac{P(D - 2t)^2}{D^2 - (D - 2t)^2} \approx -\alpha\Delta TE + vS_h$$

$$S_a = -\alpha\Delta TE + vS_h + \frac{M}{Z} + \frac{N}{A} \leq S_{Allow}$$

If axial force already contain pressure thrust force (Bourdon effect), then stress check can be done by the following equation:

$$S_a = \frac{M}{Z} + \frac{N}{A} \leq S_{Allow}$$

We got the same equation as for unrestrained zone!

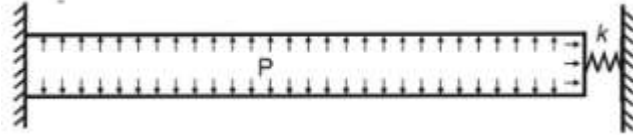


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# PASS/Start-Prof | Dry Soil Model

## Partially Restrained Pipe



$$S_a = \frac{-\alpha\Delta TE - 2\nu \frac{P(D-2t)^2}{D^2 - (D-2t)^2}}{\frac{EA}{kL} + 1} + \frac{P(D-2t)^2}{D^2 - (D-2t)^2}$$
$$\approx \frac{-\alpha\Delta TE - (0.5 - \nu)S_h}{\frac{EA}{kL} + 1} + 0.5S_h$$

If axial force already contain pressure thrust force (Bourdon effect), then stress check can be done by the following equation:

$$S_a = \frac{M}{Z} + \frac{N}{A} \leq S_{Allow}$$

The same equation as for restrained and unrestrained zone!  
More details in my articles:

[https://www.passuite.com/kbase/doc/start/WebHelp\\_en/index.htm#t=RestrainedPipe.htm](https://www.passuite.com/kbase/doc/start/WebHelp_en/index.htm#t=RestrainedPipe.htm)

<https://whatispiping.com/restrained-and-unrestrained1>

<https://whatispiping.com/restrained-and-unrestrained2>

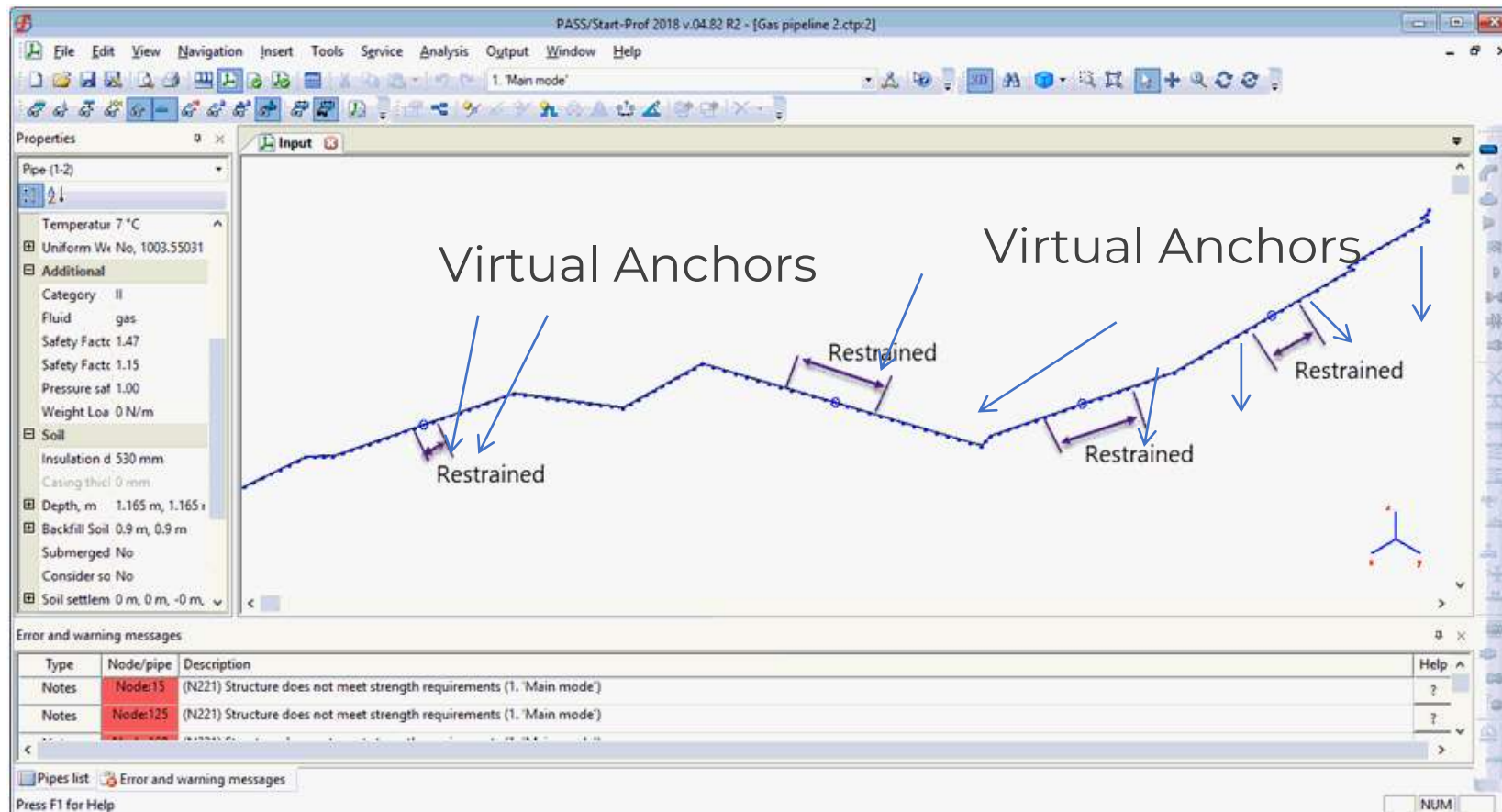


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# PASS/Start-Prof | Dry Soil Model

In fact, most of long pipelines has restrained and unrestrained zones and virtual anchors  
We need to find the position of the each virtual anchor in the pipeline system?! For each value of temperature (operating mode)?! Manually?!



# PASS/Start-Prof | Dry Soil Model

PASS/START-PROF Offers 3 Options to Solve this Problem

1) **Manual Selection** of Restrained/Unrestrained Zones

2) **Autodetect Function**. Automatically selects the type of zone for each pipe

$$\frac{F/A}{-E\alpha\Delta T + vS_H} > 0.975$$

3) **Smart start check**. The best solution. As START-PROF always consider the Bourdon effect, then we can use the more general equations to check stresses

ASME B31.4 code 402.6.2 Unrestrained Pipes from Sustained Loads

$$S_L = \frac{PD}{4t} \pm \frac{iM}{A} + \frac{F_a}{A} \leq 0.75S_y \quad \Longrightarrow \quad S_L = \pm \frac{iM}{A} + \frac{F_a}{A} \leq 0.75S_y \text{ or } 0.8S_y$$

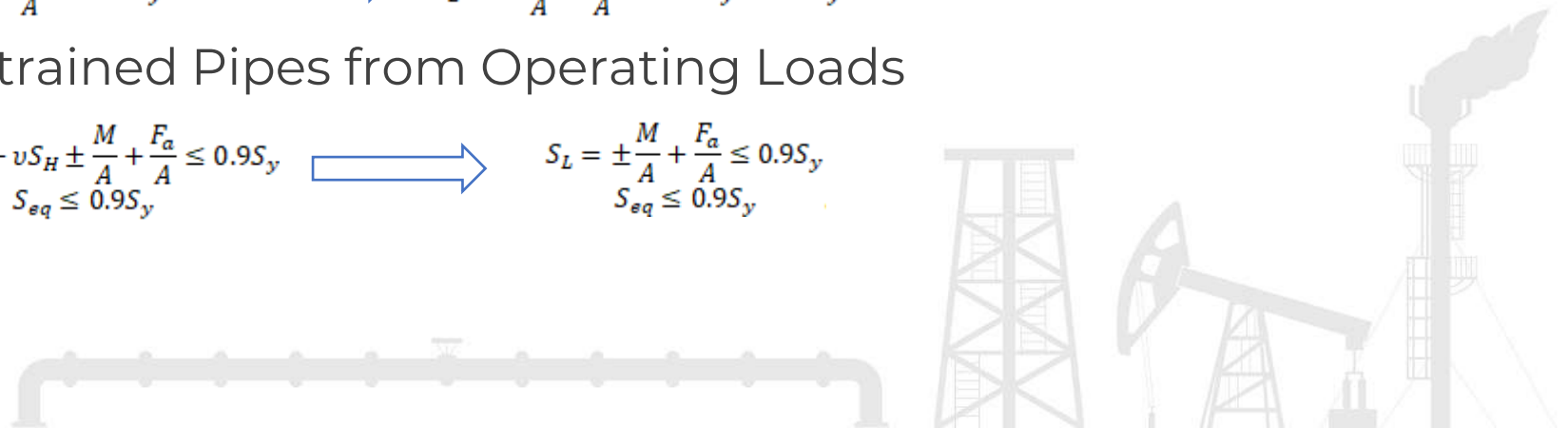
ASME B31.4 code 402.6.1 Restrained Pipes from Operating Loads

(Sustained+Expansion)

$$S_L = S_E + vS_H \pm \frac{M}{A} + \frac{F_a}{A} \leq 0.9S_y \quad \Longrightarrow \quad S_L = \pm \frac{M}{A} + \frac{F_a}{A} \leq 0.9S_y$$
$$S_{eq} \leq 0.9S_y \quad S_{eq} \leq 0.9S_y$$



PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE



# PASS/Start-Prof | Dry Soil Model

Start smart check equations does not contradict the original requirements of the code!  
If pipeline failed the “Start Smart Check”, then it will fail the original code check too!

But this feature allows to forget about Restrained/Unrestrained Zones, Virtual Anchors.  
Just Draw the pipeline and run analysis

Original ASME B31.4 Requirements

Element	Sustained, L1 SUS				Operation, L2 OPE				Expansion, L9 EXP		Test, L10	
	$S_{eq}$	allow	$S_L$	allow	$S_{eq}$	allow	$S_L$	allow	$S_E$	allow	$S_L$	allow
Onshore Pipeline												
Pipe/R	-	-	-	-	$S_{eq}$	$0.9S_y$	$S_L$	$0.9S_y$	$S_E$	$0.9S_y$	$S_L$	$0.9S_y$
Fitting/R	-	-	-	-	-	-	-	-	-	-	-	-
Pipe/U	-	-	$S_L$	$0.75S_y$	-	-	-	-	$S_E$	$S_A$	$S_L$	$0.8S_y$
Fitting/U	-	-	$S_L$	$0.75S_y$	-	-	-	-	$S_E$	$S_A$	$S_L$	$0.8S_y$
Raiser												
Pipe/W	-	-	$S_L$	$0.8S_y$	-	-	-	-	$S_E$	$0.8S_y$	$S_L$	$0.9S_y$
Fitting/W	-	-	$S_L$	$0.8S_y$	-	-	-	-	$S_E$	$0.8S_y$	$S_L$	$0.9S_y$
Offshore Pipeline (Ch. IX)												
Pipe	$S_{eq}$	$0.9S_y$	$ S_L $	$0.8S_y$	$S_{eq}$	$0.9S_y$	$ S_L $	$0.8S_y$	-	-	-	-
Fitting	$S_{eq}$	$0.9S_y$	$ S_L $	$0.8S_y$	$S_{eq}$	$0.9S_y$	$ S_L $	$0.8S_y$	-	-	-	-
Slurry Pipes (Ch. XI)												
Pipe/R	-	-	-	-	$S_{eq}$	$0.9S_y$	$S_L$	$0.9S_y$	$S_E$	$0.9S_y$	$S_L$	$0.9S_y$
Fitting/R	-	-	-	-	-	-	-	-	-	-	-	-
Pipe/U	-	-	$S_L$	$0.75S_y$	-	-	-	-	$S_E$	$S_A$	$S_L$	$0.88S_y$
Fitting/U	-	-	$S_L$	$0.75S_y$	-	-	-	-	$S_E$	$S_A$	$S_L$	$0.88S_y$

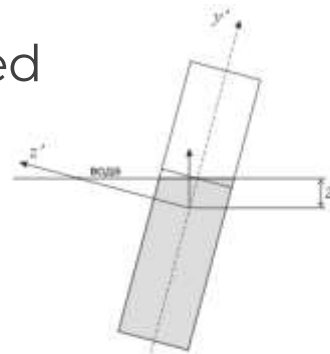
ASME B31.4 + Start Smart Check

Element	Sustained, L1 SUS				Operation L2 OPE				Expansion, L9 EXP		Test, L10	
	$S_{eq}$	allow	$S_L$	allow	$S_{eq}$	allow	$S_L$	allow	$S_E$	allow	$S_L$	allow
Onshore Pipeline												
Pipe	-	-	$S_L$	$0.75S_y$	$S_{eq}$	$0.9S_y$	$S_L$	$0.9S_y$	$S_E$	$0.9S_y    S_A$	$S_L$	$0.8S_y$
Fitting	-	-	$S_L$	$0.75S_y$	-	-	-	-	$S_E$	$S_A$	$S_L$	$0.8S_y$
Raiser												
Pipe	-	-	$S_L$	$0.8S_y$	$S_{eq}$	$0.9S_y$	$S_L$	$0.9S_y$	$S_E$	$0.8S_y$	$S_L$	$0.9S_y$
Fitting	-	-	$S_L$	$0.8S_y$	-	-	-	-	$S_E$	$0.8S_y$	$S_L$	$0.9S_y$
Offshore Pipeline (Ch. IX)												
Pipe	$S_{eq}$	$0.9S_y$	$ S_L $	$0.8S_y$	$S_{eq}$	$0.9S_y$	$ S_L $	$0.8S_y$	-	-	-	-
Fitting	$S_{eq}$	$0.9S_y$	$ S_L $	$0.8S_y$	$S_{eq}$	$0.9S_y$	$ S_L $	$0.8S_y$	-	-	-	-
Slurry Pipes (Ch. XI)												
Pipe	-	-	$S_L$	$0.75S_y$	$S_{eq}$	$0.9S_y$	$S_L$	$0.9S_y$	$S_E$	$0.9S_y$	$S_L$	$0.88S_y$
Fitting	-	-	$S_L$	$0.75S_y$	-	-	-	-	$S_E$	$S_A$	$S_L$	$0.88S_y$

# PASS/Start-Prof | Submerged Buried Pipeline

Soil Model for Submerged Buried Pipelines:

- Soil springs are placed every 5D
- The weight of pipeline, insulation and product is not removed to get the accurate results with the ballasting
- Ballasting weight objects can be added
- Water Buoyancy Considered Automatically
- Liquefied Soil Properties are taken into account automatically



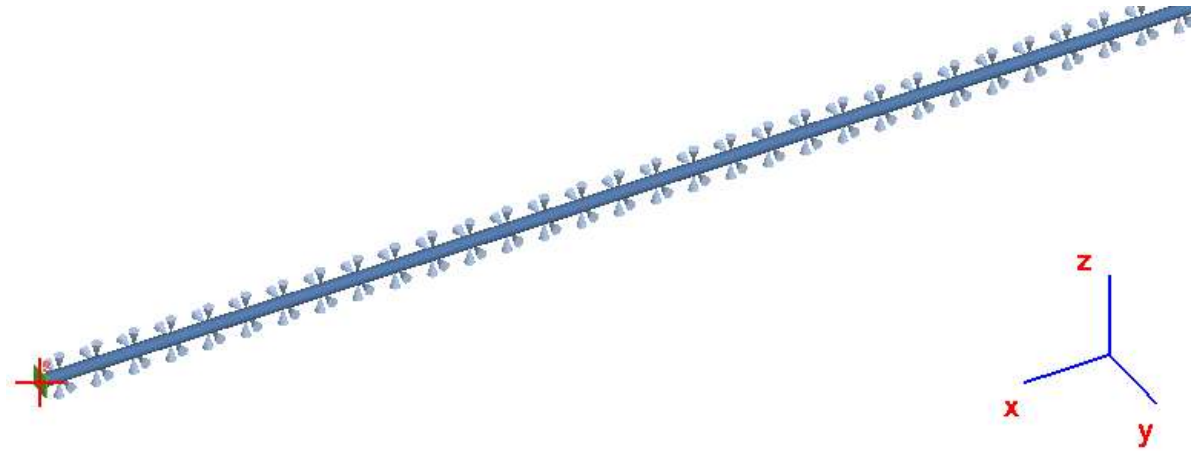
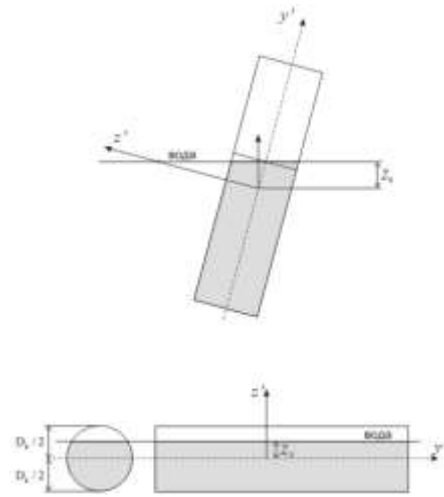
PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE





# PASS/Start-Prof | Submerged Buried Pipeline

Pops Up with Water Buoyancy

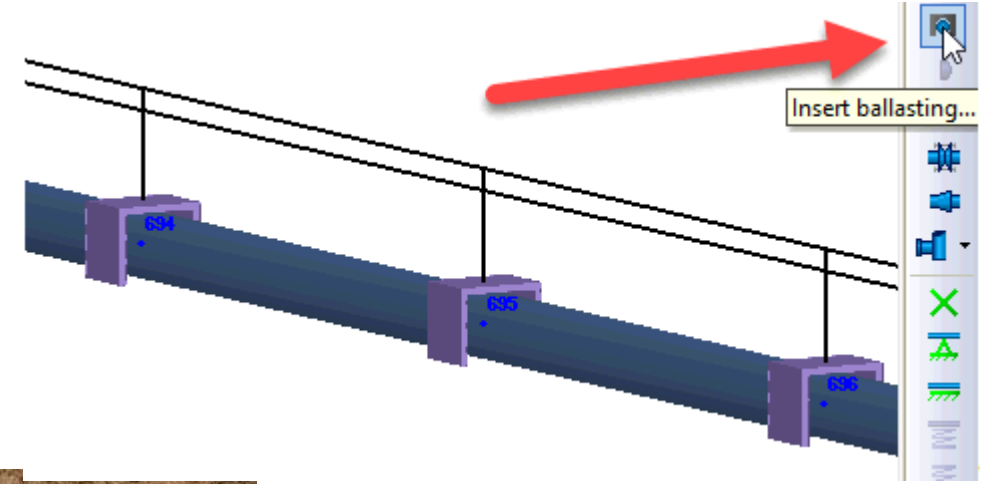
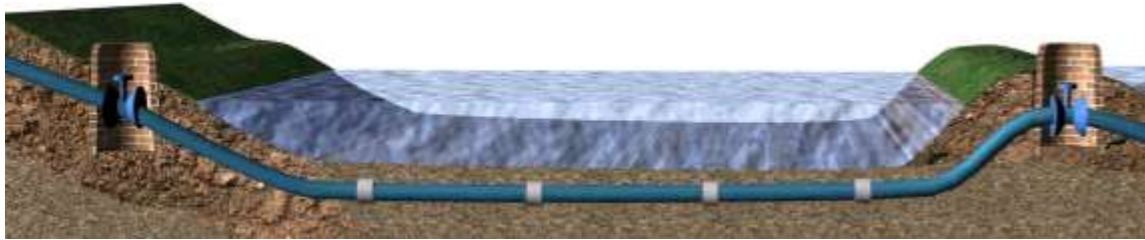


PIPING AND EQUIPMENT  
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# PASS/Start-Prof | Submerged Buried Pipeline

Ballasting Weight Object  
Lake/river crossings

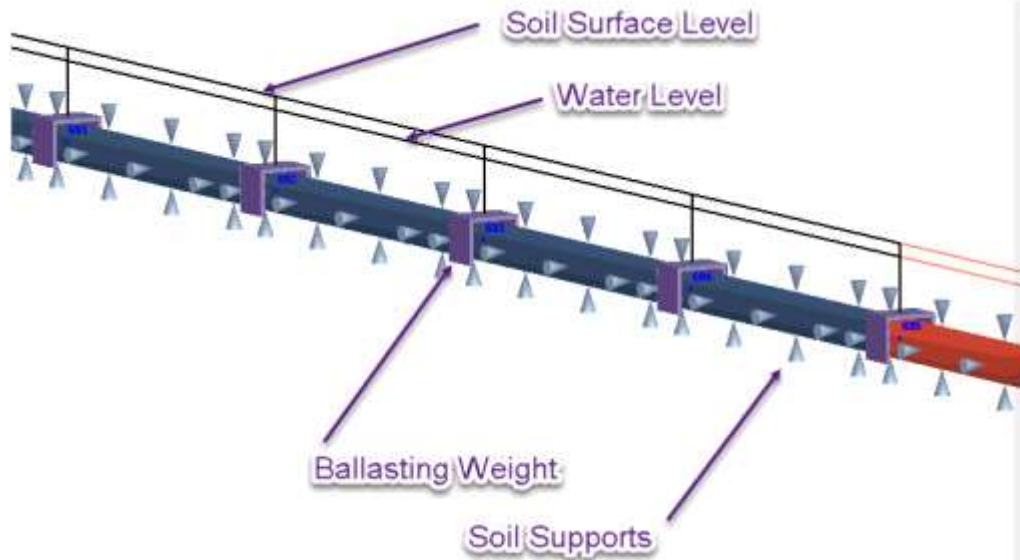


PIPING AND EQUIPMENT  
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# PASS/Start-Prof | Submerged Buried Pipeline

## Submerged Pipeline Soil Model



**Pipe Properties**

Pipe: 695-696  Pipe is Buried

Name: \_\_\_\_\_

**Main Additional Soil**

Properties

Insulation diameter: 530 mm

**Submerged Pipe** Yes

Consider Soil Movements: No

Start Node (695)

Depth to the Top of Insulation: 0.5 m

Depth to the pipe Axis: 1.165 m

Water Level From the Pipe Axis: 1 m

End Node (696)

Depth to the Top of Insulation: 0.5 m

Depth to the Pipe Axis: 1.165 m

Water Level From the Pipe Axis: 1 m

Soil

Pipe Laying Method: Open trench

Bedfill Soil Type: 03

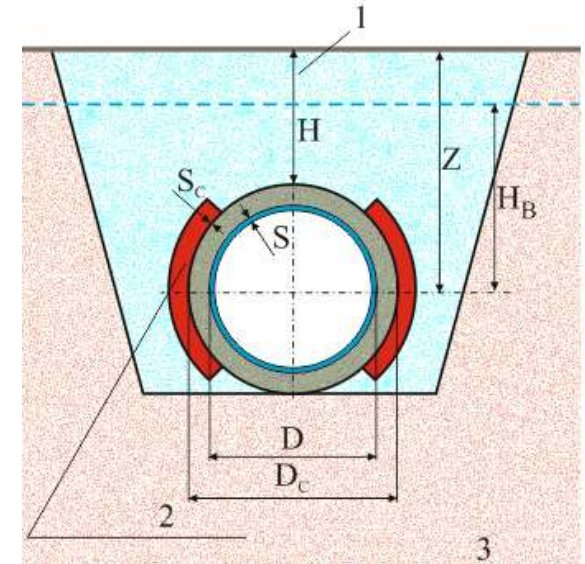
Foundation Soil Type: 03

Insulation and Cushions

Insulation Type: Other

NM: 1

OK Cancel Help



Help

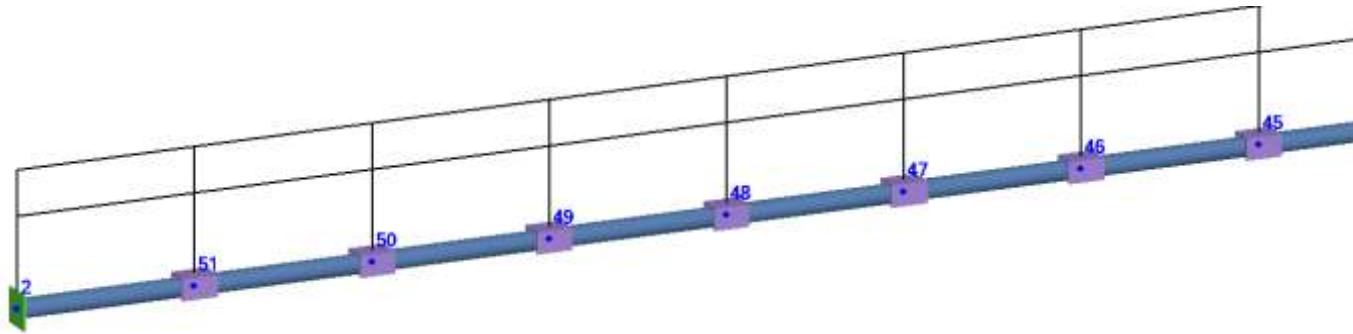
check from pressure and weight loads (1, 'Main mode')

are inserted in the node, which is not allowed (1, 'Main mode')



# PASS/Start-Prof | Submerged Buried Pipeline

Drowning With Ballasting Weights



PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE



# PASS/Start-Prof | Soil Model

---

PASS/START-PROF has a very powerful and detailed, but easy to use and fully automatic soil model. Software user's manual work is reduced to minimum.

It can easily deal with the pipelines buried in the dry soil, submerged in the liquefied soil, considering the expansion cushions and insulation stiffness, ballasting weights, horizontal, vertical, inclined pipes, combined buried and above ground (not buried) piping model, seismic wave propagation analysis, landslide, soil subsidence, seismic fault crossing, consider the natural arch of collapse for horizontal directional drilling method.

This soil model was developed at VNIIST Company (Moscow), and successfully used in 5 pipe stress analysis programs more than 35 years by lot of companies in Russia, Belarus, Ukraine, Kazakhstan, and some other countries.



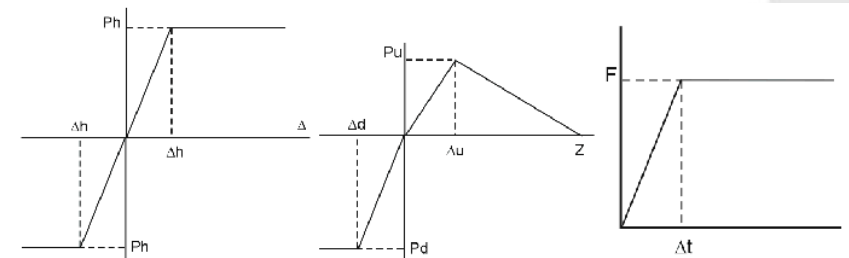
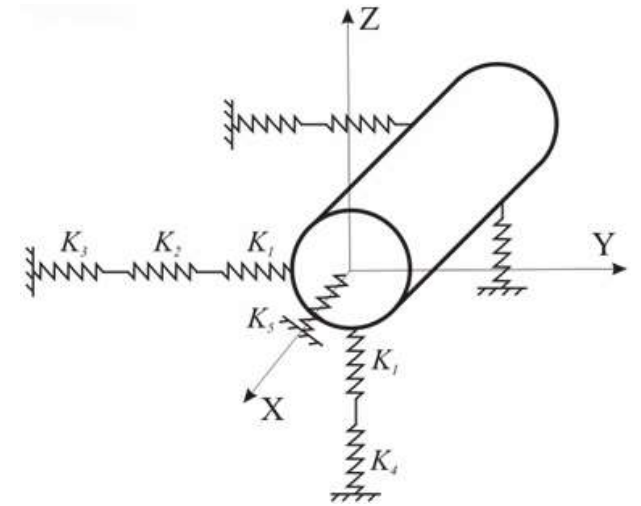
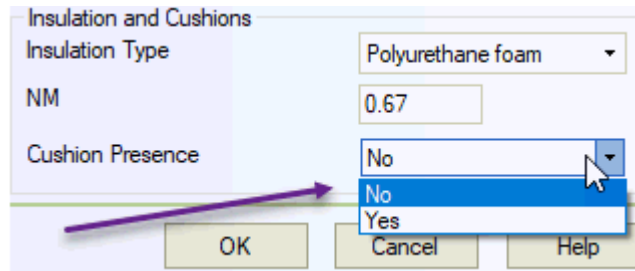
PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE



# PASS/Start-Prof | Soil Model

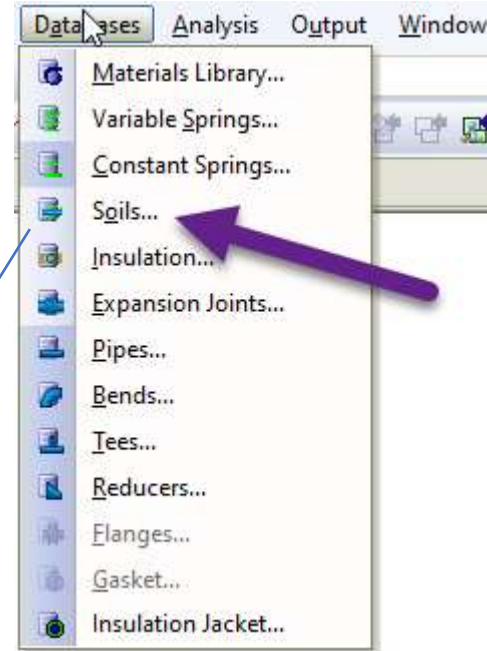
Each soil support stiffness consist of vertical, horizontal and longitudinal nonlinear springs

- 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 | New Features

## Soil Database



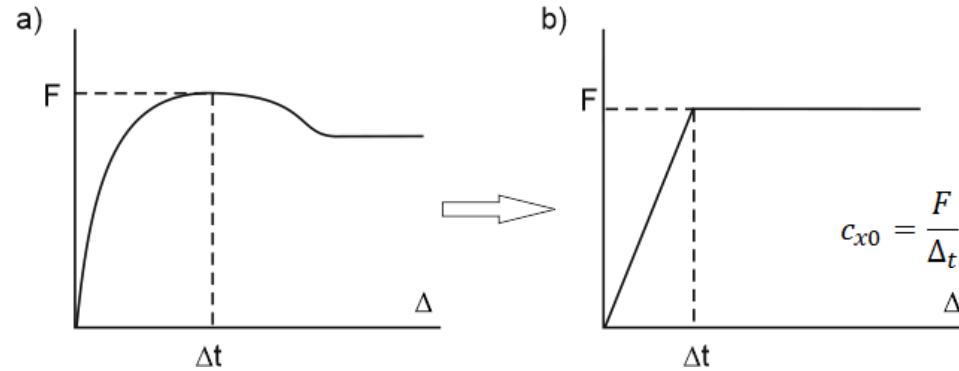
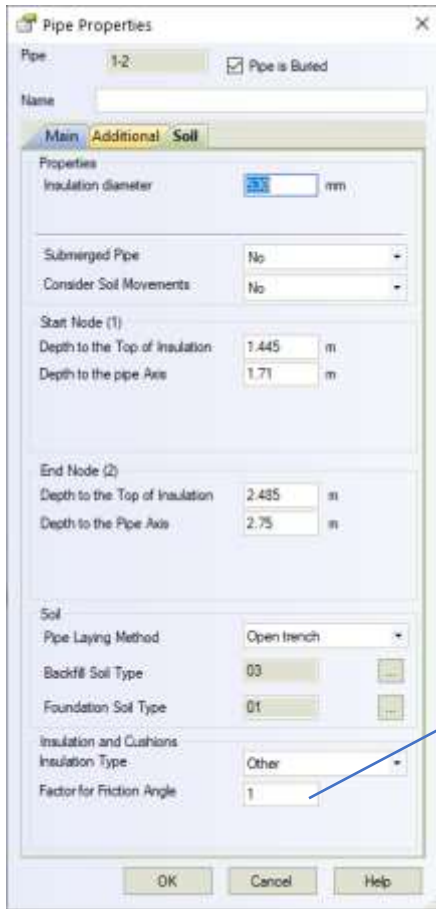
The 'Soils' window displays a table with the following columns: Code, Type, Description, E (Elastic Modulus kgf/sq.cm), ν (Poisson's Ratio), e (Void ratio), φ (Internal friction angle), γ (Unit weight kgf/cub.m), γ<sub>s</sub> (Unit weight of solid kgf/cub.m), C (Cohesion kgf/sq.cm), R<sub>s</sub> (Carrying capacity kgf/sq.cm), and C<sub>x0</sub> (Longitudinal displacement resistance factor kgf/cub.m). The table contains 6 rows of data.

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 <sub>s</sub> Unit weight of solid kgf/cub.m	C Cohesion kgf/sq.cm	R <sub>s</sub> Carrying capacity kgf/sq.cm	C <sub>x0</sub> 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

The 'Pipe Properties' dialog box is shown with the 'Soil' tab selected. The 'Backfill Soil Type' is set to '03' and the 'Foundation Soil Type' is set to '01'. Both are highlighted with a red box. Other settings include 'Pipe Laying Method' set to 'Open trench', 'Insulation Type' set to 'Other', and 'Factor for Friction Angle' set to '1'. The 'Start Node (1)' and 'End Node (2)' sections show depths to the top of insulation and the pipe axis.

# PASS/Start-Prof | Soil Model

## Longitudinal Bi-linear Soil Spring Model



$$F = \mu(2\pi D_c^2 C_h \bar{\gamma} + G) + 0.6\pi D_c C$$

$\mu$  – Friction factor

$$\mu = tg(\varphi \cdot n_m)$$

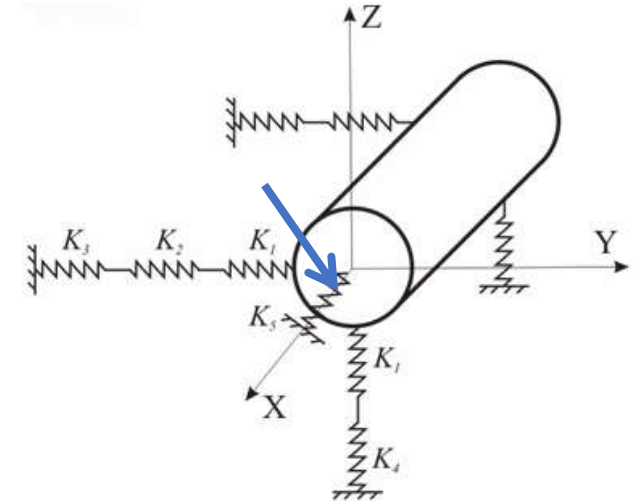
$D_c$  – Insulation casing outer diameter

$C$  – Soil Cohesion from database

$\varphi$  – Soil internal friction angle from database

$G$  – Pipe, Insulation, Product weight, minus Buoyancy

$n_m$  - Insulation adhesion factor. For steel pipes without insulation  $n_m = 1$ , f  
 $n_m = 0.67$



$C_s = -0.056\beta^2 + 0.416\beta + 0.095$  - For sand and sandy loam

$C_c = -0.046\beta^2 + 0.367\beta + 0.06$  - For clay and loam

$$\beta = \begin{cases} \frac{Z}{D_c} & \frac{Z}{D_c} < 4 \\ 4 & \frac{Z}{D_c} \geq 4 \end{cases}$$

$\bar{\gamma}$  – Effective soil unit weight, considering the water liquefaction effect.

For horizontal pipes it is calculated using the following method:

- If the pipe is above the water level, then  $\bar{\gamma} = \gamma$
- If the pipe is below the water level, then

$$\bar{\gamma} = \frac{\gamma_s - \gamma_w}{1 + e}$$

For vertical and horizontal pipes the more complex equations are used, we will skip it to simplify the understanding.

$\gamma$  – Dry soil unit weight from soil database

$\gamma_s$  – Soil particle unit weight from soil database

$\gamma_w$  – Water unit weight

$e$  – Void Ratio

$$e = \frac{V_v}{V_s} = \frac{\gamma_s - \gamma}{\gamma} = \frac{n}{1 - n}$$

$V_v$  – Volume of the void space

$V_s$  – Volume of the solids

$n$  – Porosity

All needed soil data is stored in the START-PROF soil database



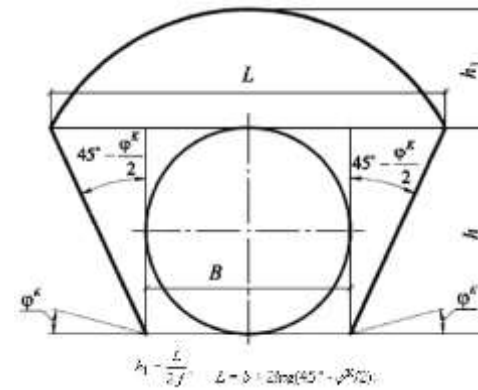
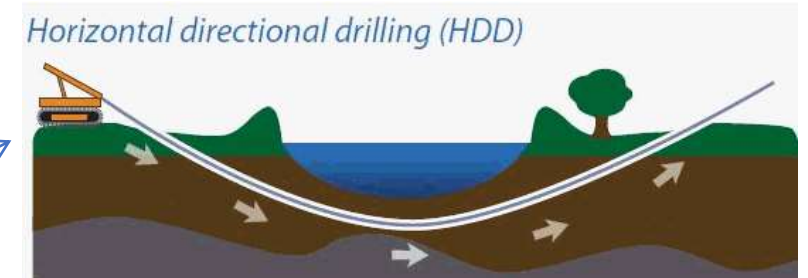
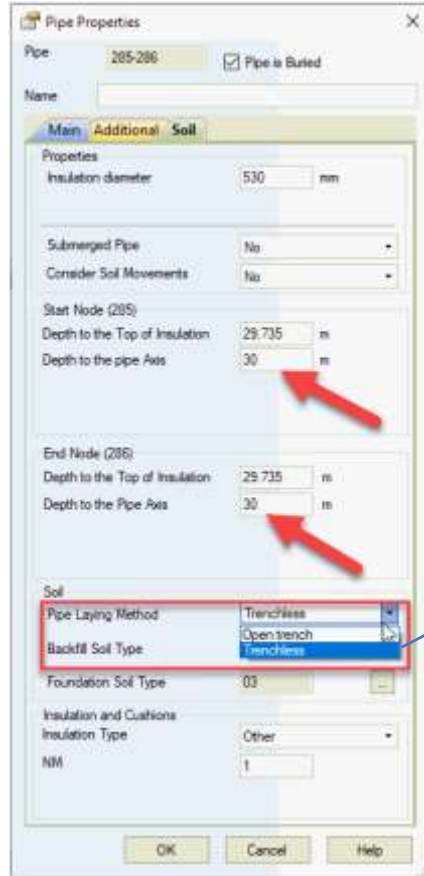
PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE



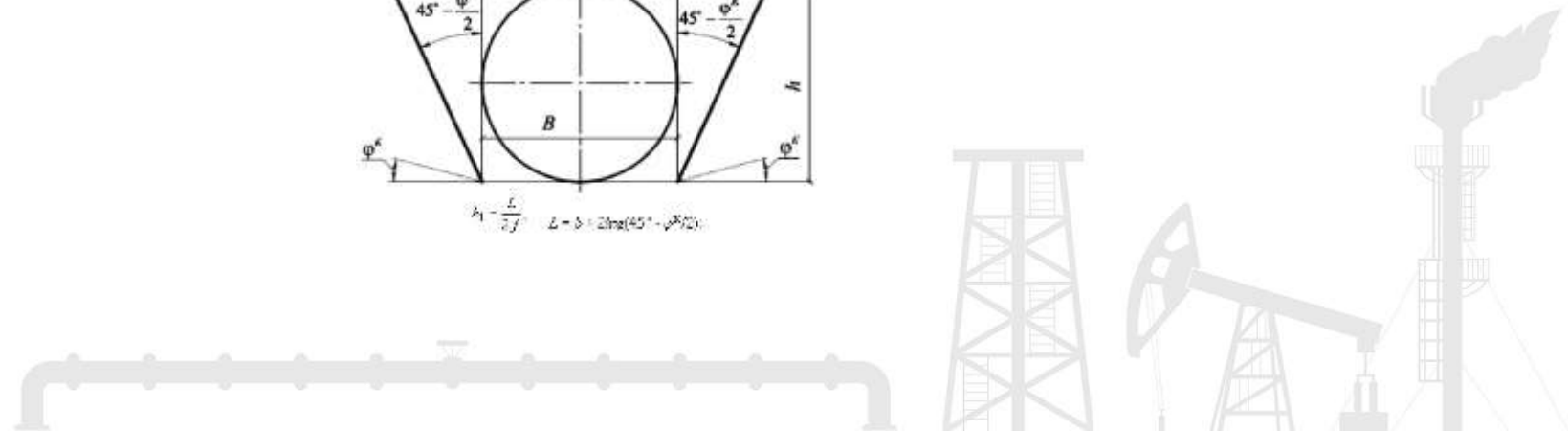


# PASS/Start-Prof | Soil Model

## Natural Arch of Collapse Phenomena

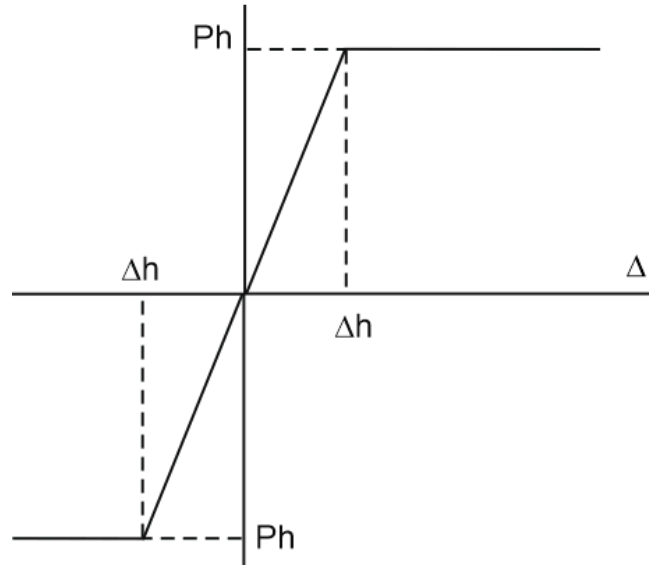


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# PASS/Start-Prof | Soil Model

## Lateral Bi-linear Soil Spring Properties



Lateral soil stiffness is calculated using the equation

$$K_L = \frac{P_h}{\Delta_h} = \frac{0.12E\eta}{(1-\nu^2)\sqrt{D_c}} \left( 1 - \frac{P_h}{R_s} \right)$$

$Z$  – Soil spring depth from the surface to the pipe axis

$$\eta = 0.547\beta^2 - \beta + 0.854$$

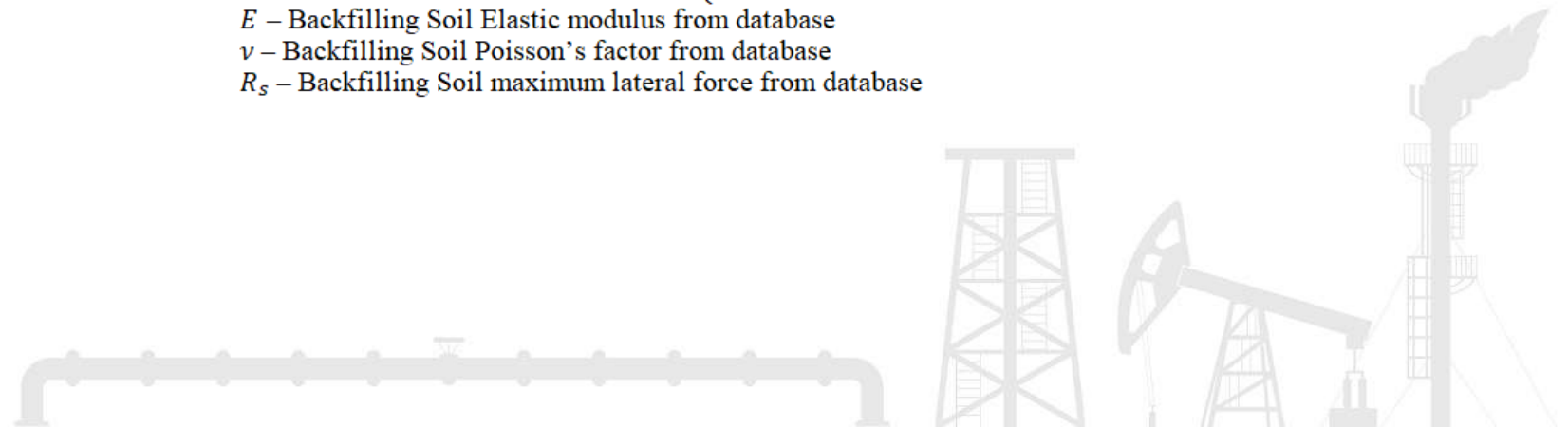
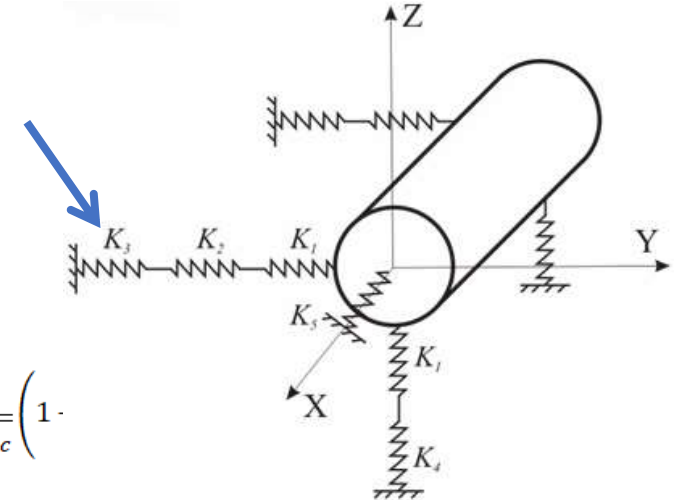
$$\beta = \begin{cases} \frac{a}{Z} & \text{if } a/Z < 1 \\ 1 & \text{if } a/Z \geq 1 \end{cases}$$

$$a = \begin{cases} 150 & \text{if } D_c < 700\text{mm} \\ 0.25D_c & \text{if } D_c \geq 700\text{mm} \end{cases}$$

$E$  – Backfilling Soil Elastic modulus from database

$\nu$  – Backfilling Soil Poisson's factor from database

$R_s$  – Backfilling Soil maximum lateral force from database



# PASS/Start-Prof | Soil Model

## Vertical Tri-linear Soil Spring Properties

Trilinear diagram is used for vertical springs

Vertical downward soil stiffness is calculated using the equation

$$K_d = \frac{P_d}{\Delta d} = \frac{0.144E_2}{(1 - \nu_2^2)\sqrt{D_c}}$$

$$P_d = R_{s2}$$

Vertical upward soil stiffness is calculated using the equation

$$K_u = \frac{P_u}{\Delta u} = \frac{0.072E\eta_v}{(1 - \nu^2)\sqrt{D_c}} \left(1 - e^{-\frac{2Z}{D_c}}\right)$$

$$\eta_v = \begin{cases} 1 & \text{if } Z_w \leq Z \\ 0.5(2 - Z_w/Z) & \text{if } 0 < Z_w < Z \\ 0.5 & \text{if } Z_w > Z \end{cases}$$

$$P_d = \bar{\gamma}D_c \left(Z - \frac{\pi}{8}D_c\right) + k \left(\bar{\gamma}Z^2 \tan 0.7\phi + \frac{0.7ZC}{\cos 0.7\phi}\right)$$

$\bar{\gamma}$  – Effective soil unit weight, considering the water liquefaction effect.

For horizontal pipes it is calculated using the following method:

- If the pipe is above the water level, then

$$\bar{\gamma} = \gamma$$

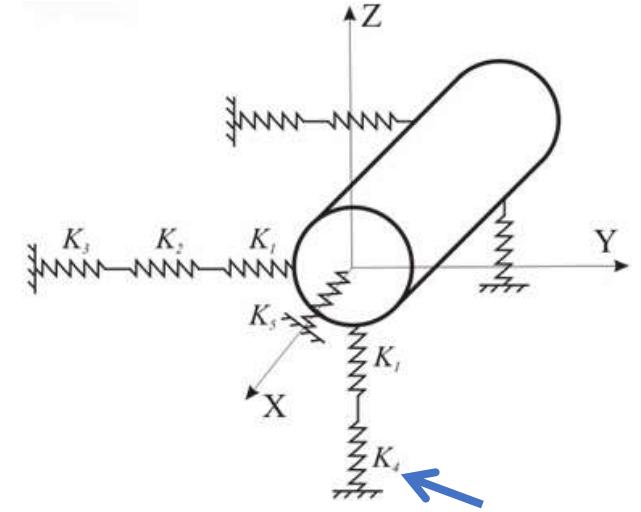
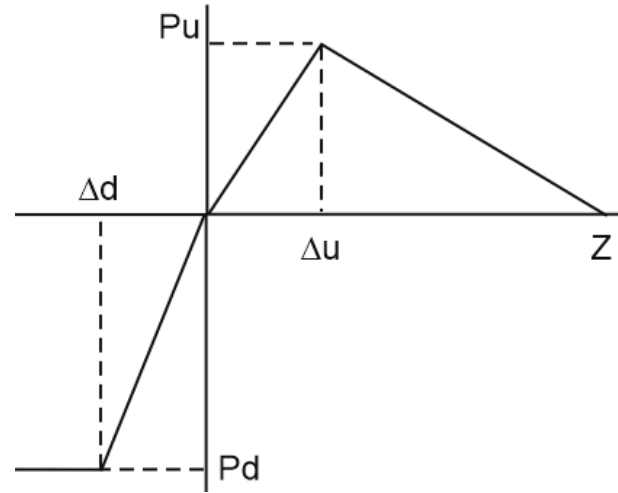
- If the pipe is below the water level, then

$$\bar{\gamma} = \gamma \frac{Z - \frac{\pi}{8}D_c - Z_w}{Z - \frac{\pi}{8}D_c} + \frac{\gamma_s - \gamma_w}{1 + e} \frac{Z_w}{Z - \frac{\pi}{8}D_c}$$

- If the water level is within the pipe then

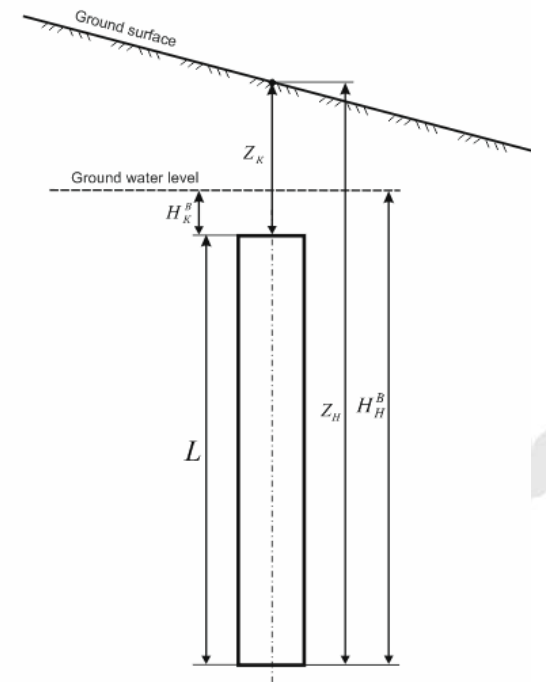
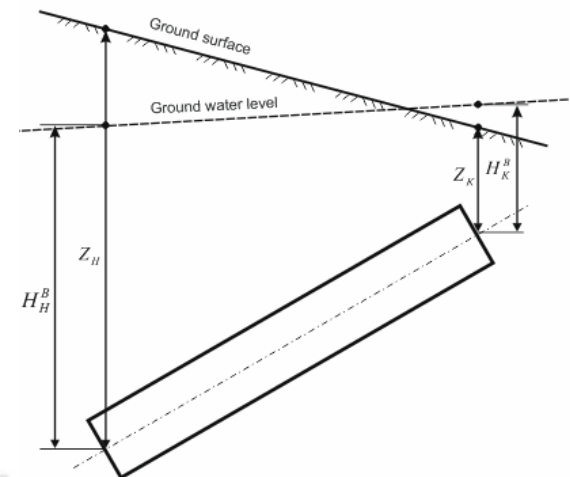
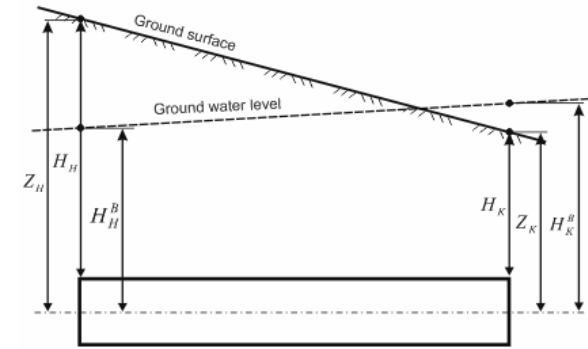
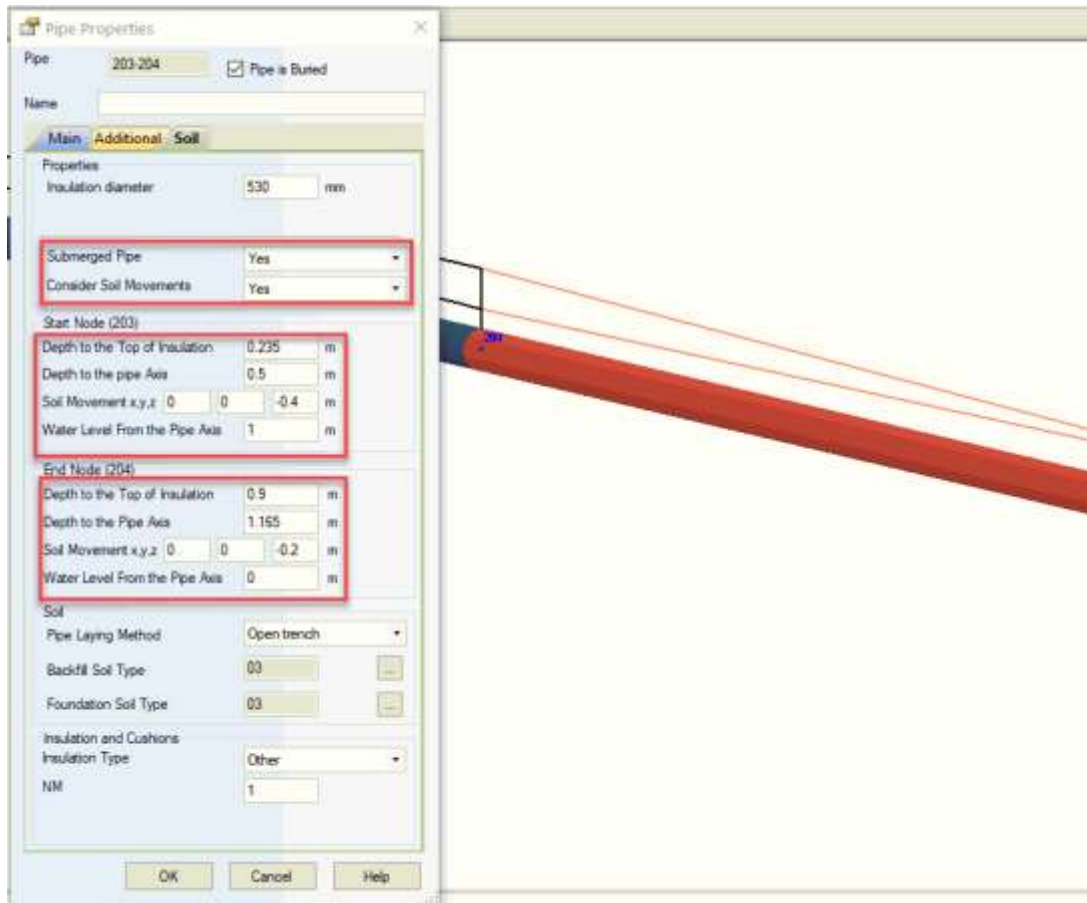
$$\bar{\gamma} = \gamma \frac{Z - Z_w - \frac{\pi}{4}D_c + V_w/D_c}{Z - \frac{\pi}{8}D_c} + \frac{\gamma_s - \gamma_w}{1 + e} \frac{Z_w + \frac{\pi}{8}D_c - V_w/D_c}{Z - \frac{\pi}{8}D_c}$$

$$V_w = \frac{D_c^2}{8} (\alpha - \sin \alpha)$$



# 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

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

(A) ACTUAL GEOMETRY

Soil drop,  $\Delta$

backfill soil weight

Soil defrosting

GROUND SURFACE

UPLIFT RESISTANCE

HEAVE FORCES

PIPELINE

ORIGINAL PIPE ELEVATION

Pipe Properties

Pipe: 3633-3634  Pipe is Buried

Name:

Main Additional Soil

Properties

Outer Casing Diameter: 1652 mm

Casing Wall Thickness: 20 mm

Consider Soil Movements: Yes

Start Node (3633):

Depth to the Top of Insulation: 1.474 m

Depth to the Pipe Axis: 2.3 m

Soil Movement x,y,z: 0 0 -0 m

End Node (3634):

Depth to the Top of Insulation: 1.474 m

Depth to the Pipe Axis: 2.3 m

Soil Movement x,y,z: 0 0 -0 m

Soil

Pipe Laying Method: Open trench

Backfill Soil Type: 04

Foundation Soil Type: 04

Insulation and Cushions

Insulation Type: Polyurethane foam

Insulation adhesion factor: 0.57

Cushion Presence: No

OK Cancel Help



PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE

# PASS/Start-Prof | Soil Model

Landslide, Soil subsidence, frost heaving, Permanent ground deformation (seismic fault crossing) strain check is made according to ASCE 2001 (ALA) and GB 50470

* #	Name	Hanger Sizing	Installation State	Seismic	Wind	Snow/Ice	Friction Multiplier	Weight Multiplier	Mode Type	Stress Range Between	Help
1 (0)	Operating Mode	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1.00	1.00	SUS	1-1A	?
2 (2)	Landslide	<input type="checkbox"/>					1.00	1.00	ASCE 2001 (ALA)		?
3 (1)	Test										?

Object	Start End node	Landslide strength, (MPa)			Landslide strength, (%)			Notes
		SI	Allow	%	Σ	Allow	%	
Buried pipe	1	48.45	1930.53	2.5	0.02399	0.5	4.8	12
	2	135	1930.53	7.0	0.05584	E, 201906.18 MPa		12
Bend	2	171.56	1930.53	8.9		[εa]=0.005		
Buried pipe	2	135.94	1930.53	7.0	0.05573	[εa]%=0.5		12
	3	26.46	1930.53	1.4	0.01311	0.5	2.6	12

Longitudinal strain from ground movement due to earthquake, landslide, or mine subsidence, combined with thermal strain	N/A <sup>2</sup>	<p><b>Operable limits<sup>4,5</sup></b></p> <p>Tension strain limit 2%</p> <p>Compression strain limit</p> $0.50 \left( \frac{t}{D'} \right) - 0.0025 + 3000 \left( \frac{pD}{2Er} \right)^2$ $D' = \frac{D}{1 - \frac{3}{D}(D - D_{min})}$ <p><b>Pressure integrity limits<sup>4,5</sup></b></p> <p>Tension strain limit 4%</p> <p>Compression strain limit <math>1.76 \frac{t}{D}</math></p>
---	------------------	--



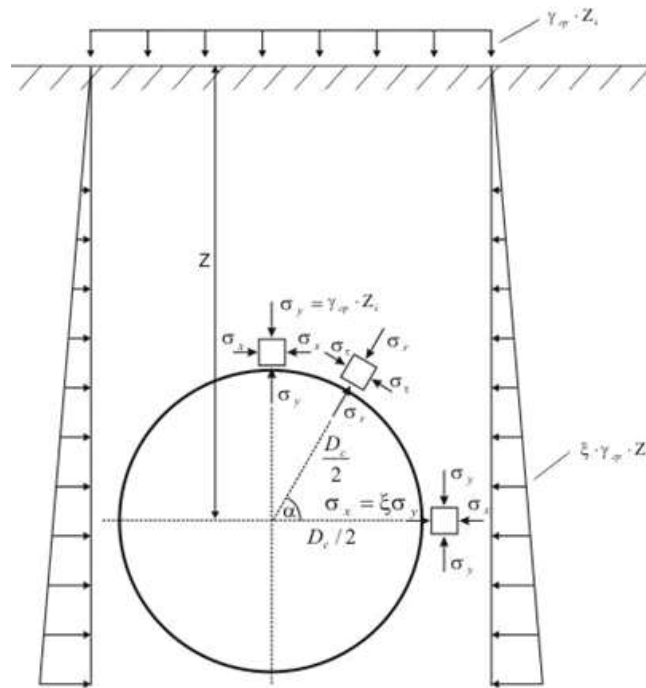
PIPING AND EQUIPMENT ANALYSIS & SIZING SUITE





# PASS/Start-Prof | Soil Model

To calculate the ring bending stresses the finite element model of pipe cross-section is used. The loads from the soil weight are calculated and applied for each point of pipe cross-section at whole perimeter.



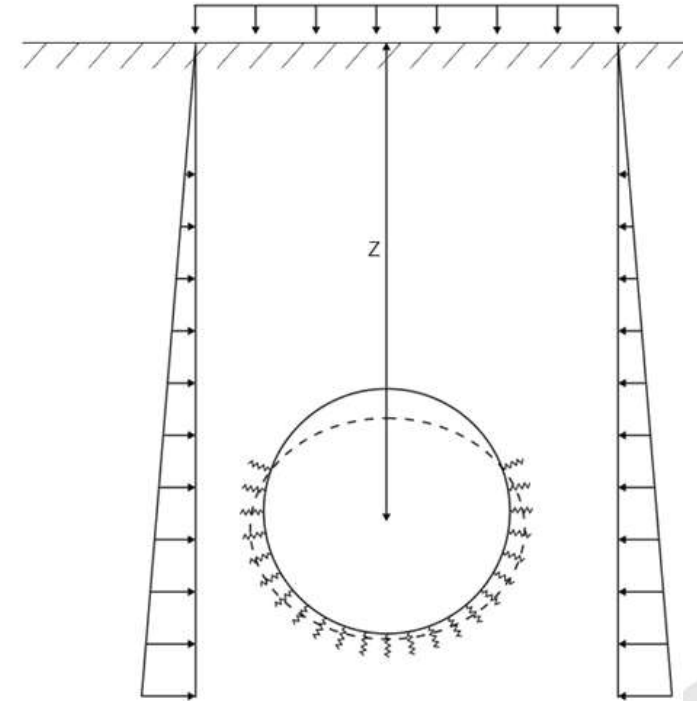
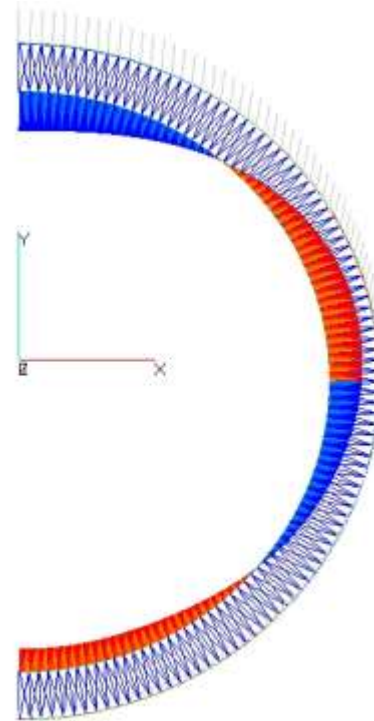
PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE



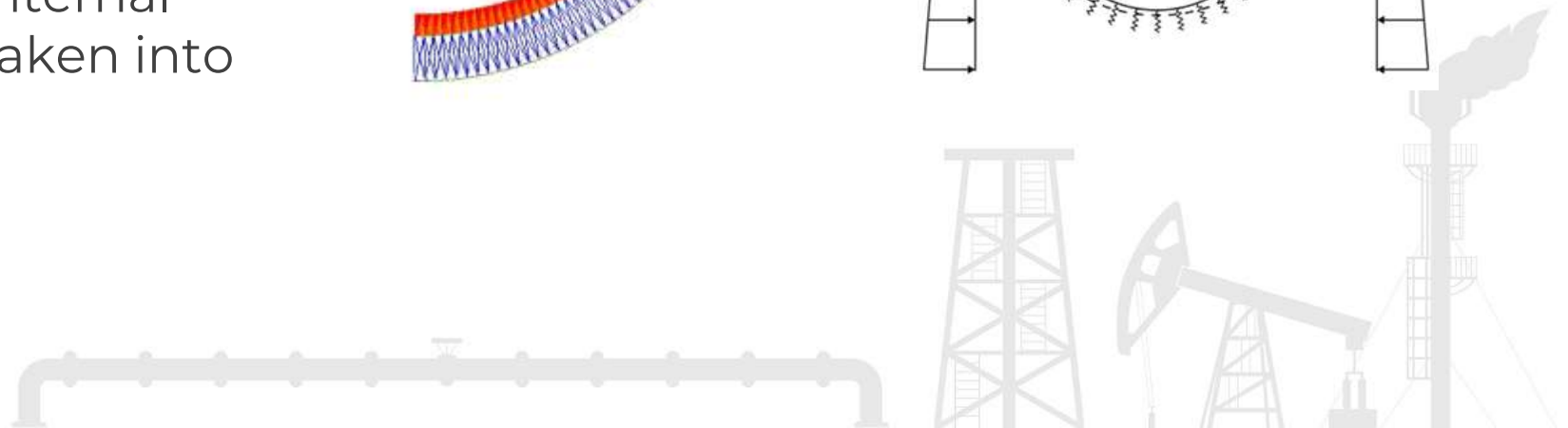
# PASS/Start-Prof | Soil Model

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

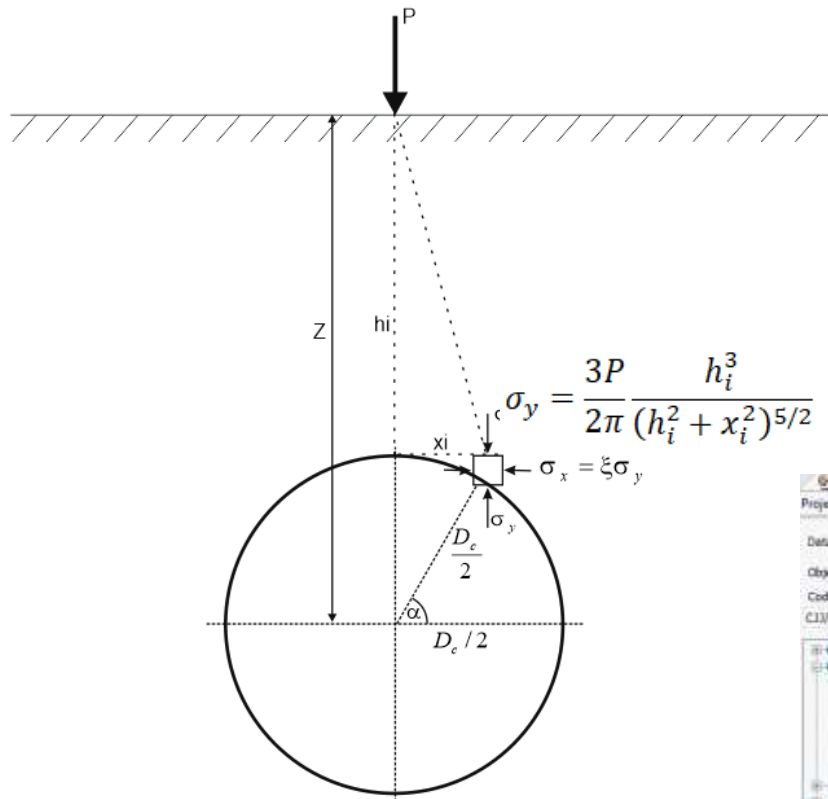


PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE

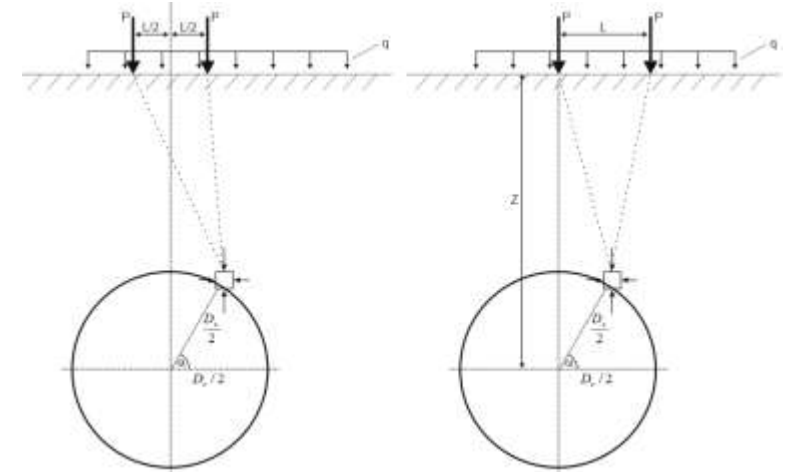


# PASS/Start-Prof | Soil Model

## Pipe and Insulation Strength Against the Surface Heavy Truck Loading



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



Trubodetail software interface showing project data, material properties, and a 3D model of a pipe under load.

Parameter	Value	Unit
Outside Diameter: D	1020	mm
Pipe Wall Thickness: S	12	mm
Ambient Temperature	0	°C
Operating Temperature	100	°C
Pipe Weight	149.08	kg/m
Fluid Weight	790.01	kg/m³
Insulation Weight	67.55	kg/m³
Operating Pressure	1.6	MPa
Material	20	-
Surface load	Single force	-
Axle load: P	1000	kgf
Distributed load: q	50	kgf/m
Soil	04	-
Backfill Soil Code	01	-
Foundation Soil Code	-	-
Output	0.5	m
Depth: Z	0.5	m

STRENGTH CONDITIONS NOT MET  
 Equivalent stress, MPa  
 operation: 437.92  
 allowable: 133

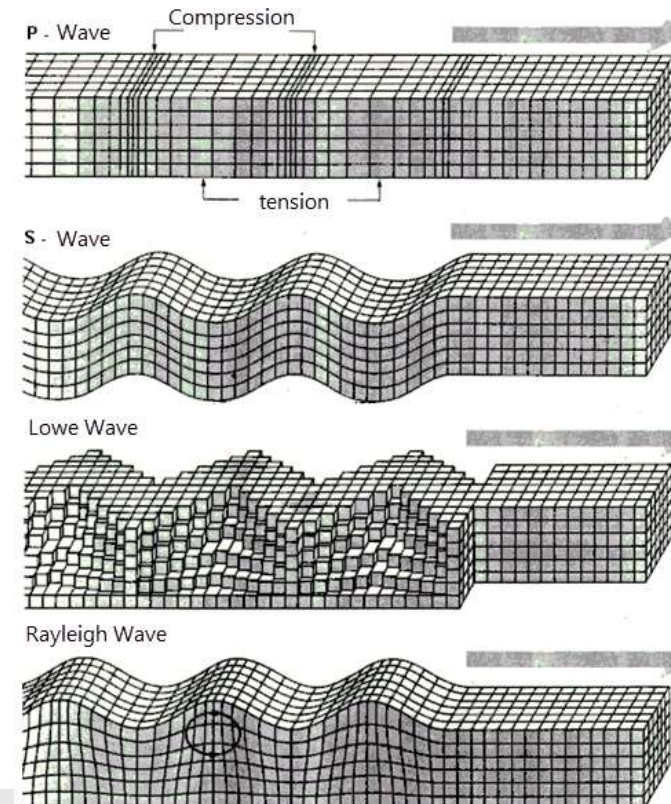


PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE

# PASS/Start-Prof | Seismic Wave Propagation

Seismic wave propagation analysis for underground pipelines. START-PROF calculate stress and strain in buried pipeline caused by seismic wave propagation and check the stress and strain limits according to:

- ASCE 2001 Guidelines for the Design of Buried Steel Pipe (American Lifelines Alliance). Improved by START-PROF authors, added shear wave effect
- GB 50032 (China)
- GB 50470 (China)
- SNiP 2.05.06-85 (Russia)
- SP 36.13330.2012 (Russia)
- GOST R 55989-2014 (Russia)
- GOST R 55990-2014 (Russia)
- SP 284.1325800.2016 (Russia)
- SP 33.13330.2012 (Russia)



# PASS/Start-Prof | Seismic Wave Propagation

Project Settings... - 1snip.ctp

General Additional **Seismic** Wind, Snow, Ice Other Dynamic

Analyze seismic acceleration code User defined Acceleration

Horizontal Acceleration (X) 1 G's

Horizontal Acceleration (Y) 1 G's

Vertical Acceleration (Z) 0.7 G's

Perform Buried Pipeline Seismic Wave Propagation Analysis

Buried Pipeline Seismic Analysis Code ASCE 2001(ALA)  
SNIP/SP/GOST  
ASCE 2001(ALA)  
GB 50032  
GB 50470

Characteristic Period of Ground Motion in pipe buried site sec

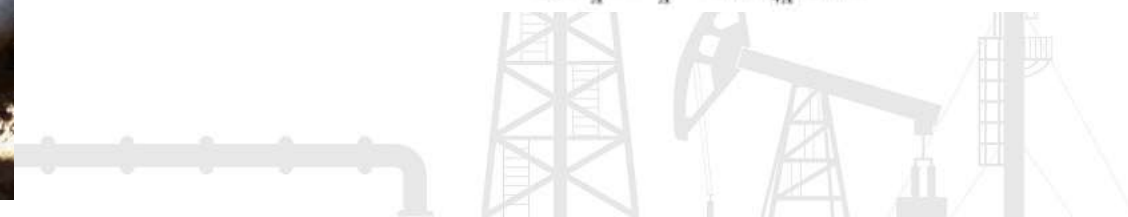
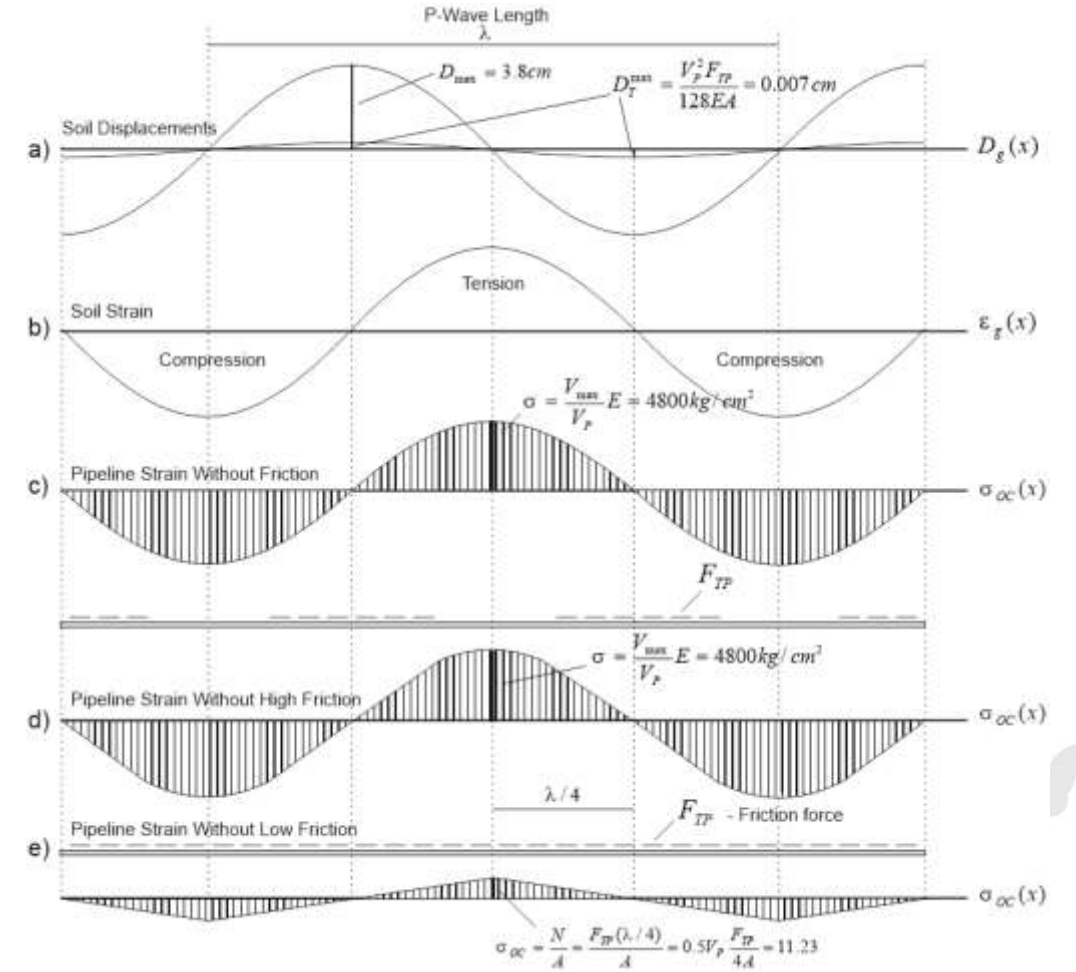
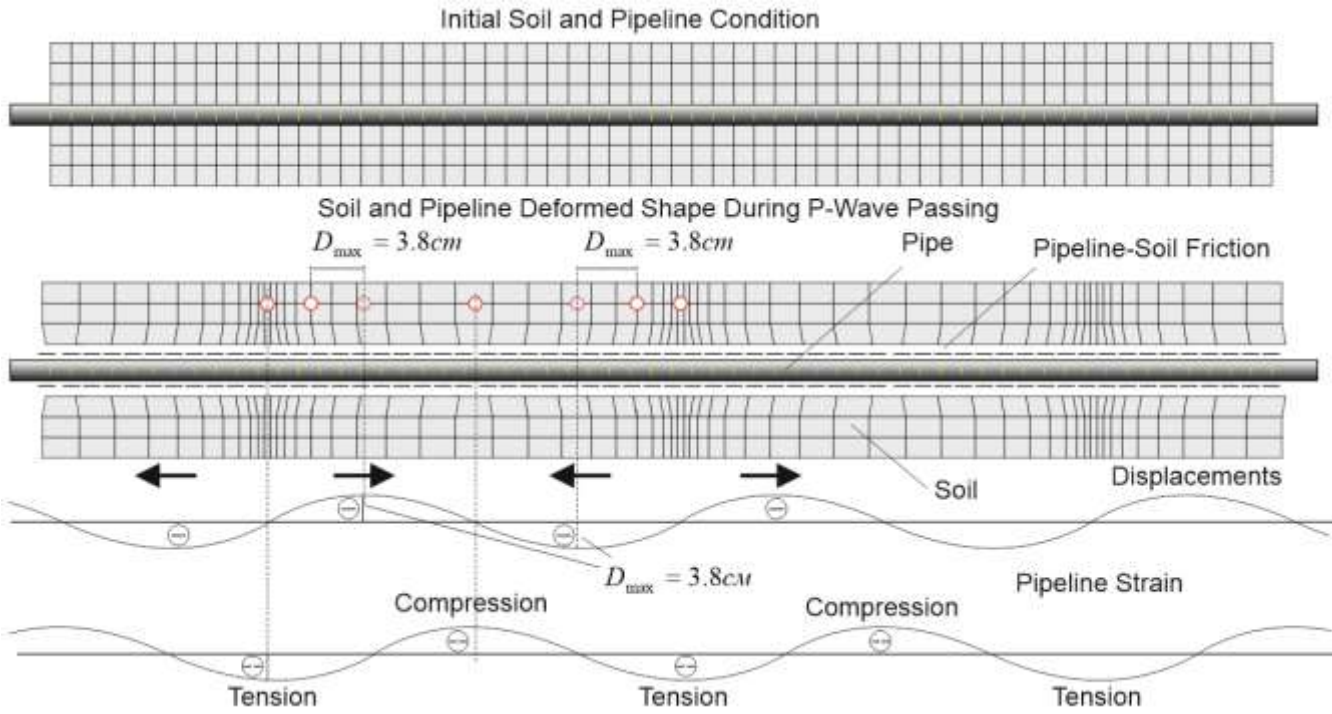
OK Cancel Help



PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE

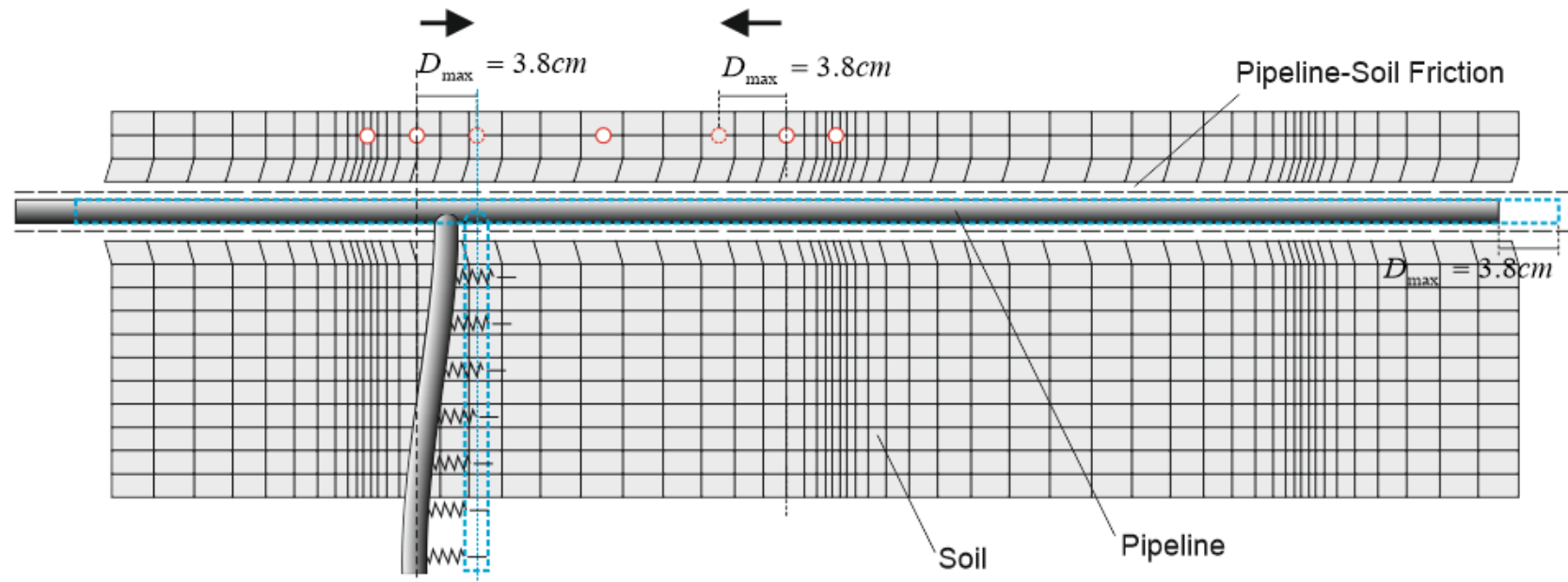


# PASS/Start-Prof | Seismic Wave Propagation

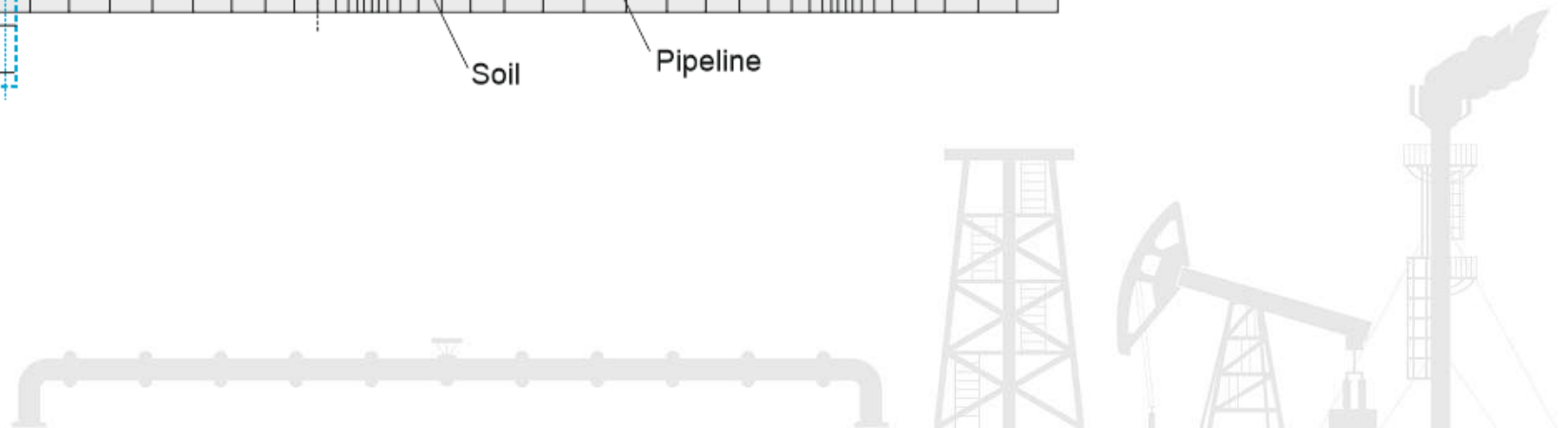


# PASS/Start-Prof | Seismic Wave Propagation

Every pipe branch, turn or anchor cause great axial and bending stresses



PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE



# PASS/Start-Prof | Seismic Wave Propagation

Axial seismic strain due to wave propagation is calculated using equation:

$$\varepsilon = \pm \max \left( \min(\varepsilon_a, \varepsilon_{fr}); \frac{D}{2} \rho_{max} \right) \cos \omega$$

Actually, pipe curvature can cause only the bending moments, but we convert it into equivalent axial strain to simplify the stress analysis procedure in START-PROF software.

$\omega$  – Incline angle of the pipe. 0 for horizontal pipe, 90 for vertical pipe

$D$  – Pipe diameter, m

$\varepsilon_a$  – Maximum axial strain from P-, S-, R-waves

$$\varepsilon_a = \max \left( \frac{V_g}{C_p}; \frac{V_g}{2C_s}; \frac{V_g}{C_R} \right)$$

Maximum strain from P-wave friction forces is

$$\frac{T_u \lambda}{4EA}$$

$\lambda$  – Wave length, m

$$\lambda = 0.5C_p$$

So maximum strain caused by friction from P-, S-, R-waves is

$$\varepsilon_{fr} = \max \left( 0.5C_p \frac{T_u}{4EA}; 0.5C_s \frac{T_u}{4EA}; 0.5C_R \frac{T_u}{4EA} \right)$$

$\rho_{max}$  – Maximum curvature from P-, S-, R-waves

$$\rho_{max} = \max \left( \frac{0.385A_g}{(C_p)^2}; \frac{A_g}{(C_s)^2}; \frac{A_g}{(C_R)^2} \right)$$

$V_g$  – Peak ground velocity, m/s. Specified by user in pipe properties

$A_g$  – Peak ground acceleration, m/s<sup>2</sup>. Specified by user in pipe properties

$A$  – Pipe cross-section area, m<sup>2</sup>

$T_u$  – Peak friction force, t/m

$$T_u = \tan(n_m \cdot \varphi) \left[ \gamma_a Z \pi D_c \left( \frac{1 + K_0}{2} \cos^2 \alpha - K_0 \sin^2 \alpha \right) \right] + \pi D_c \omega c$$

$$\omega = 0.608 - 0.123c - \frac{0.274}{c^2 + 1} + \frac{0.695}{c^3 + 1}$$

$c$  – Soil cohesion

$C_p$  – Apparent P-wave propagation velocity, m/s. Specified by user in START-PROF pipe properties. Default value 2

km/s

$C_s$  – Apparent S-wave propagation velocity, m/s. Specified by user in START-PROF pipe properties. Default value 1

km/s

$C_R$  – Apparent R-wave propagation velocity, m/s

Rayleigh wave velocity is equal to  $C_R = kC_s$ , where  $k$  is obtained from the equation

$$\frac{1}{8}k^6 - k^4 + \frac{2-\nu}{1-\nu}k^2 - \frac{1}{1-\nu} = 0.$$

Depending on Poisson's ratio values the  $k$  values are within  $0.92 < k < 0.95$  We approximately assume that  $k = 0.92$

$$C_R \approx 0.92C_s$$

**Pipe Properties**

Pipe: 160-180  Pipe is Buried

Name: \_\_\_\_\_

**Main Additional Soil Seismic**

Piping Location

Aboveground/in Underground Channel/On Low Restraints Installation

Overpass/On the Stand/At the First Floor and Above Installation

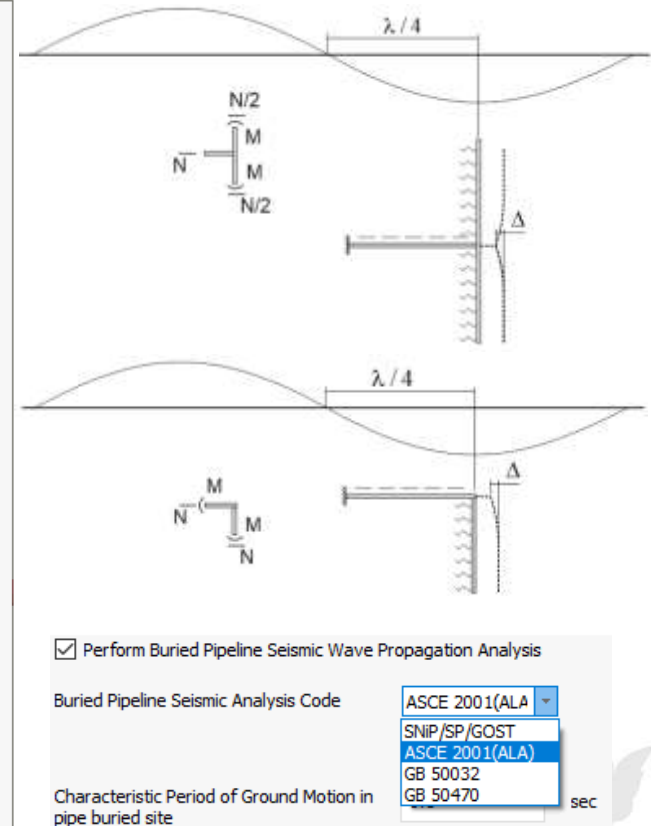
Automatic Calculation of Kpsi

Factor to Account for the Ability to Dissipate Energy, Kpsi: 1.48

Factor Taking Into Account the Appointment of the Piping, K0: 1.5

Peak Ground Velocity, Vg	0.1	m/s
Peak Ground Acceleration, Ag	4	m/s <sup>2</sup>
Apparent Propagation Velocity, Ca	120	m/s
Shear Wave Velocity, Cs	60	m/s

OK Cancel Help





# PASS/Start-Prof | Seismic Wave Propagation

Added strain check according to ASCE 2001 Guidelines for the Design of Buried Steel Pipe (American Lifelines Alliance), SNIp, SP, GOST, GB Codes

Operating Mode: 1.1 'Soil Seismic Wave Propaga'  Show Equations  Stress Range from Operation to Cold  Add Axial Force and Torsion Stress

Object	Start End node	Buried piping Seismic Check, (MPa)			Buried piping Seismic Check, (%)			Notes
		SI	Allow	%	Σ	Allow	%	
Buried pipe	9	515.60	965.27	53.4	0.2009	0.2939	68.4	
	3	515.58	965.27	53.4	0.2009	0.2939	68.4	
Buried pipe	8	510.81	965.27	52.9	0.1985			E, 201051.12 MPa
	9	515.60	965.27	53.4	0.2009			[εa]=0.75(0.5t/D-0.0025+3000(PD/(2Et)) <sup>2</sup> ), 0.002939
Buried pipe	7	490.91	965.27	50.9	0.1884			[εa]%, 0.2939
	8	510.81	965.27	52.9	0.1985			

Tension strain limit 5%

Compression strain limit

$$0.75 \left[ 0.50 \left( \frac{t}{D'} \right) - 0.0025 + 3000 \left( \frac{pD}{2Et} \right)^2 \right]$$

$$D' = \frac{D}{1 - \frac{3}{D}(D - D_{min})}$$

Operating Mode: Maximum  Show Equations  Stress Range from Operation to Cold  Add Axial Force and Torsion Stress

Object	Start End node	Hoop Stress, (MPa)			Primary Loads Stress in Hot State, (MPa)						Primary&Secondary Loads Stress in Hot State, (MPa)						Expansion Stress Range, (MPa)			Buried piping Seismic Check, (MPa)			Buried piping Seismic Check, (%)			Notes
		Sh	F*E*Sy	%	Seq	F*Sy	%	SI	F*Sy	%	Seq	F*Sy	%	SI	F*Sy	%	Se	Sa	%	SI	Allow	%	Σ	Allow	%	
Buried pipe	9	85	173.75	48.9				24.62	180.99	13.6	154	217.18	70.9	69	217.18	31.8	93.61	217.18	43.1	515.60	965.27	53.4	0.2009	0.2939	68.4	
	3	85	173.75	48.9				24.62	180.99	13.6	154	217.18	70.9	69	217.18	31.8	93.61	217.18	43.1	515.58	965.27	53.4	0.2009	0.2939	68.4	
Buried pipe	8	85	173.75	48.9				24.69	180.99	13.6	153.55	217.18	70.7	68.55	217.18	31.6	93.23	217.18	42.9	510.81	965.27	52.9	0.1985	0.2939	67.5	
	9	85	173.75	48.9				24.62	180.99	13.6	154	217.18	70.9	69	217.18	31.8	93.61	217.18	43.1	515.60	965.27	53.4	0.2009	0.2939	68.4	
Buried pipe	7	85	173.75	48.9				24.98	180.99	13.8	151.70	217.18	69.9	66.70	217.18	30.7	91.60	217.18	42.2	490.91	965.27	50.9	0.1884	0.2939	64.1	
	8	85	173.75	48.9				24.69	180.99	13.6	153.55	217.18	70.7	68.55	217.18	31.6	93.23	217.18	42.9	510.81	965.27	52.9	0.1985	0.2939	67.5	
Long Radius Pipe Bend	2	85	173.75	48.9				35.27	180.99	19.5	204.13	217.18	94.0	119.13	217.18	54.9	84.97	217.18	39.1	732.51	965.27	75.9	0.1589	0.2939	54.1	
Buried pipe	2	85	173.75	48.9				30.03	180.99	16.6	169.99	217.18	78.3	84.99	217.18	39.1	84.91	217.18	39.1	568.23	965.27	58.9	0.1588	0.2939	54.0	
	7	85	173.75	48.9				24.98	180.99	13.8	151.70	217.18	69.9	66.70	217.18	30.7	91.60	217.18	42.2	490.91	965.27	50.9	0.1884	0.2939	64.1	



# PASS/Start-Prof | Seismic Wave Propagation

The pipeline strain check is made according to ASCE 2001 (ALA) and GB 50470

* #	Name	Hanger Sizing	Installation State	Seismic	Wind	Snow/Ice	Friction Multiplier	Weight Multiplier	Mode Type	Stress Range Between	Help
<input checked="" type="checkbox"/>	1 (0) Operating Mode	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1.00	1.00	SUS	1-1A	?
<input checked="" type="checkbox"/>	2 (2) Landslide	<input type="checkbox"/>					1.00	1.00	ASCE 2001 (ALA)		?
<input checked="" type="checkbox"/>	3 (1) Test								SUS OCC Test ASCE 2001 (ALA) GB 50470		?

Operating Mode: 2 'Landslide' (2)  
Expansion Stress Range: 1 '操作模式' (0) (2-1A)  
Show Equations:   
Stress Range from Operation to Cold:   
Add Axial Force and Torsion Stress:

Object	Start End node	Landslide strength, (MPa)			Landslide strength (Tension Area), (%)			Landslide strength (Compression Area), (%)			Notes
		SI	Allow	%	$\epsilon$	Allow	%	$\epsilon$	Allow	%	
Buried pipe	1	48.20	1930.53	2.5	0.02387	2	1.2	-0.02386	2	1.2	
	2	186.69	1930.53	9.7	0.09247	2	4.6	-0.02027	2	1.0	
Buried pipe	2	77.07	1930.53	4.0	0.03817	2	1.9	0.03403	0.7304	4.7	
	3	45.84	1930.53	2.4	0.0227	0.7304	3.1	-0.0227			E, 201906.18 MPa [ $\epsilon$ ]=0.5t/D-0.0025+3000(PD/(2Et)) <sup>2</sup> , 0.007304 [ $\epsilon$ ]%, 0.7304



# PASS/Start-Prof | Features

Automatic local pipe wall buckling check per

- ASME B31.8-2018
- EN 13941-2019 7.2.4.2
- GOST 32388



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

$$\left(0.4 \frac{t}{D} - 0.002 + 2400 \left(\frac{P \cdot D}{2t \cdot E}\right)^2\right) E \text{ at } \frac{P \cdot D}{2t \cdot E} < 0.4$$

$$\left(0.4 \frac{t}{D} - 0.002 + 2400 \left(\frac{0.4 \cdot S}{E}\right)^2\right) E \text{ at } \frac{P \cdot D}{2t \cdot E} \geq 0.4$$

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	1	36.09	33.88	38.39	33.88	
	2	12.95	33.88	34.84	33.88	0	33.88	2
Bend	2							
Buried pipe	2	21.44	33.88	34.63	33.88	0	33.88	2
	3	35.93	33.88	38.89	33.88	0.01	33.88	1,2

Object	Start End node	Axial Stress From All Loads in Hot condition, (kgf/sq.cm)		Axial Stress From all loads in Cold condition, (kgf/sq.cm)		Axial Stress From All Loads in Test Mode, (kgf/sq.cm)		Notes
		calculated	allowable	calculated	allowable	calculated	allowable	
		Above ground pipe	7,Bend			492.22	18345.53	
Above ground pipe	33	2963.95	17774.76	2963.95	18345.53	1771.67	18322.60	
	32,Offshore	219.58	17774.76	219.59	18345.53	219.47	18322.60	
Above ground pipe	35	4055.33	17774.76	4055.34	18345.53	2412.27	18322.60	
	34,Offshore Raiser	273.36	17774.76	273.37	18345.53	273.20	18322.60	

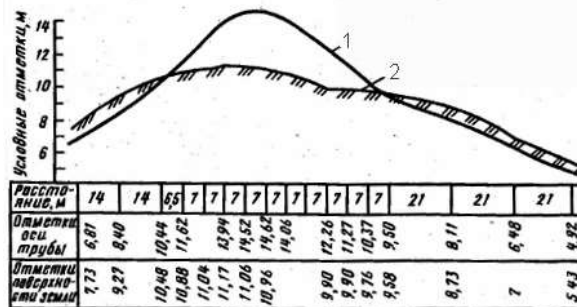


PIPING AND EQUIPMENT ANALYSIS & SIZING SUITE



# PASS/Start-Prof | Features

## Upheaval buckling analysis in START-Elements



Project tree...  
 Date: 15-06-2020  
 Object Number:   
 Code:   
 SNAP 2.05.06-85 Gas & oil transmission piping:   
 Pipe, Above ground  
 Wall thickness analysis: 0  
 Stability analysis: 0  
 Span length analysis: 0  
 Pipe, Buried  
 Wall thickness analysis: 0  
 Stability analysis: 0  
 Pipe elongation: 0  
 Long-radius bend stability: 0  
 Pipe strength against surface load: 0  
 Pipe, Buried pipe in embankment  
 Bend  
 Tee  
 Reducer  
 Cap  
 L-, Z-, U-shaped pipe loops, Above-ground  
 L-, Z-, U-shaped pipe loops, Above-ground  
 L-, Z-, U-shaped pipe loops, Buried

Pipe Outside Diameter, D: 0 mm  
 External Casing Diameter (if absent), Dc: 0 mm  
 Pipe Wall Thickness, S: 0 mm  
 Operating Temperature: 0 °C  
 Pipe Weight: 0 kg/m  
 Fluid Weight: 0 kg/m  
 Insulation Weight: 0 kg/m  
 Pipeline Category: B  
 Pressure safety factor (SNP table 13): 1.1  
 Material:   
 Backfill Soil Code: 04  
 Friction Factor: 0.67  
 Axis force  
 Depth, Z: 0 m

Project tree...  
 Date: 15-05-2020  
 Object Number:   
 Code:   
 SNAP 2.05.06-85 Gas & oil transmission piping:   
 Pipe, Above ground  
 Wall thickness analysis: 0  
 Stability analysis: 0  
 Span length analysis: 0  
 Pipe, Buried  
 Wall thickness analysis: 0  
 Stability analysis: 0  
 Pipe elongation: 0  
 Long-radius bend stability: 0  
 Pipe strength against surface load: 0  
 Pipe, Buried pipe in embankment  
 Bend  
 Tee  
 Reducer  
 Cap  
 L-, Z-, U-shaped pipe loops, Above-ground  
 L-, Z-, U-shaped pipe loops, Above-ground  
 L-, Z-, U-shaped pipe loops, Buried

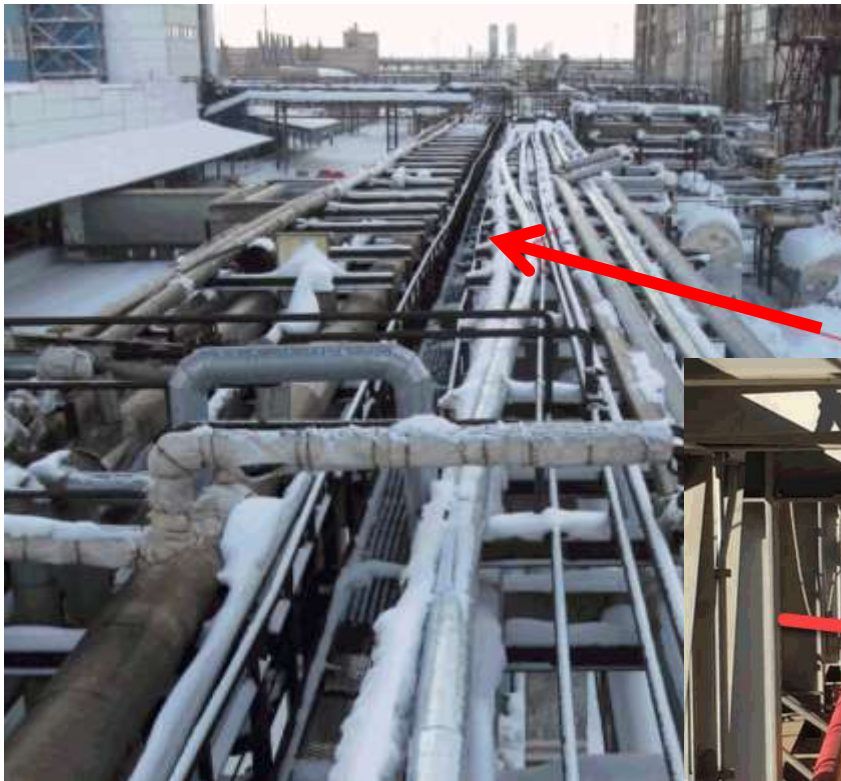
Outside Diameter, D: 0 mm  
 Pipeline Category: B  
 Pressure safety factor (SNP table 13): 1.1  
 Pipe Wall Thickness: 0 mm  
 External Casing Diameter (if absent), Dc: 0 mm  
 Ambient Temperature: 0 °C  
 Operating Temperature: 0 °C  
 Backfill Soil Code: 04  
 Foundation Soil Code: 01  
 Insulation Type: Other  
 Operating Pressure: 0 kgf/cm²  
 Material:   
 Pipe: 0 kg/m  
 Fluid: 0 kg/m  
 Insulation: 0 kg/m  
 Depth to Pipe Center, Z: 0 m  
 Curve Radius: 0 m  
 Incline Angle to Horizon: φ 0  
 Run bend angle: α 0



PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE

# PASS/Start-Prof | Features

Lateral buckling analysis of above ground pipeline in START-Elements



PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE

A screenshot of the Trubodetail2 software interface. The interface shows a project tree on the left, a central panel with various analysis parameters, and a diagram of a pipe cross-section on the right. The parameters include:

- Date: 15-06-2020
- Object Number: [empty]
- Code: GMP 2.05.06-85 Gas & oil transmission piping
- Project tree:
  - Pipe: Above ground
    - Wall thickness analysis: 0
    - Stability analysis: 1.0
    - Span length analysis: 0
  - Pipe: Buried
    - Pipe: buried pipe in embankment
  - Bend
  - Tees
  - Reducer
  - Cap
  - L, Z, U-shaped pipe loops: Above-ground
  - L, Z, U-shaped pipe loops: Above-ground
  - L, Z, U-shaped pipe loops: Buried

The central panel shows:

- Outer Diameter, D: 0 mm
- Pipe Wall Thickness, S: 0 mm
- Operating Temperature: 0 °C
- Pipe Weight: 0 kg/m
- Rud Weight: 0 kg/m
- Insulation Weight: 0 kg/m
- Friction Factor in Resting Supports: 0.3
- Pipeline Category: B
- Pressure safety factor (SNIP table 13): 1.1
- Free length factor: 0
- Material: [empty]
- Distance between guide supports, L<sub>gr</sub>: 0 m
- Load force, N: 0 kgf

The diagram on the right shows a pipe cross-section with diameter D and wall thickness S. Below it, a 3D diagram shows a pipe supported by a series of supports, with a red arrow indicating the direction of lateral displacement. The length between supports is labeled L<sub>gr</sub>.

# PASS/Start-Prof | Piping Model Creation

In PASS/START-PROF the piping model creation is simple and straightforward.  
Even a beginner will understand what to do.

Create the Piping and Equipment Model by Combining the Objects  
Like LEGO

- Fast Model Creation
- Fast and Easy Existing Model Modification
- You can Add, Delete, Modify, Copy, Rotate, Mirror, Split Objects
- Work With Object Groups

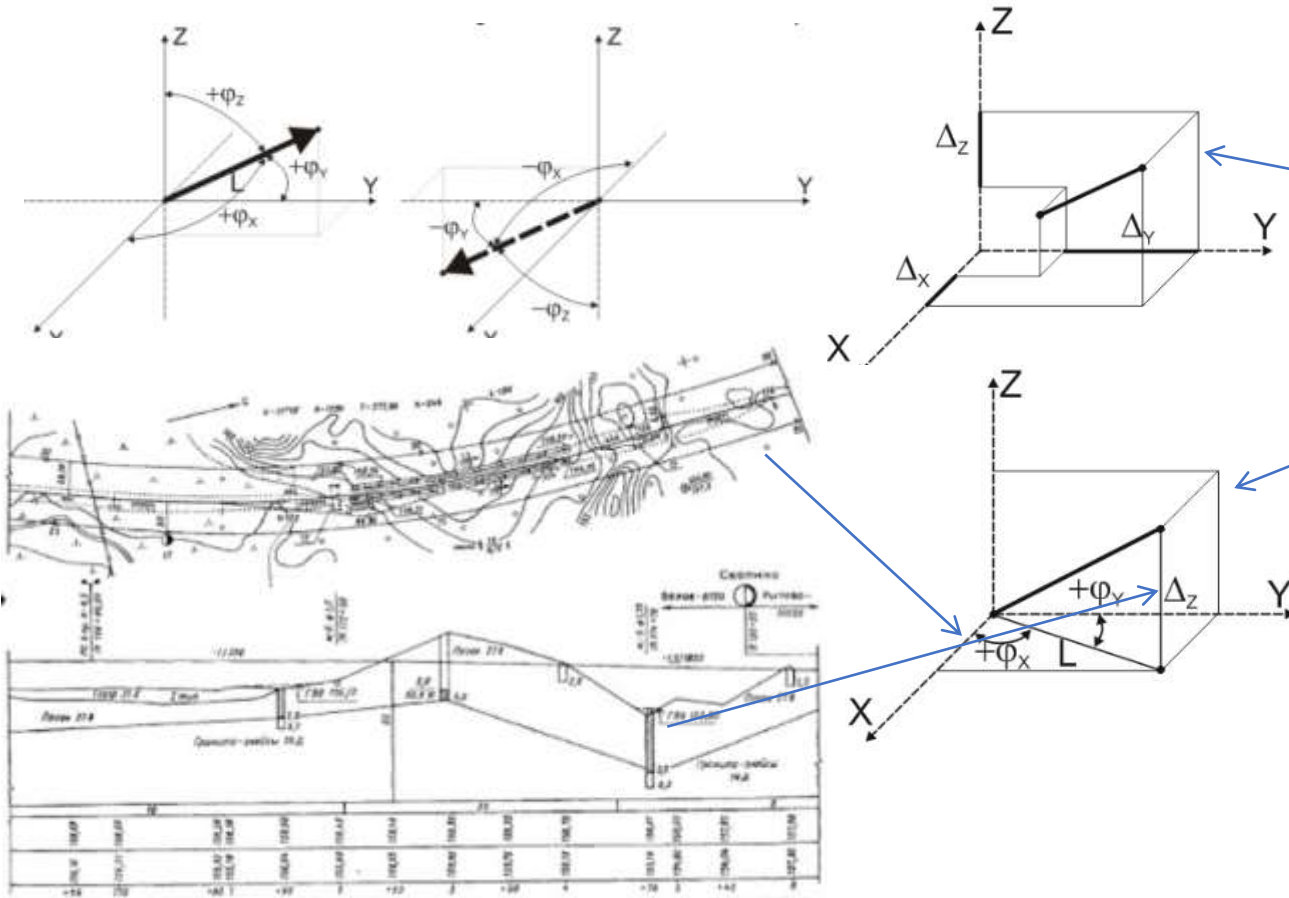


PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE



# PASS/Start-Prof | Piping Model Creation

Pipe Object with several coordinate systems



The image shows two screenshots of the 'Pipe Properties' dialog box, illustrating the configuration of a pipe object. The left screenshot shows the 'Main' tab with the 'projections' dropdown selected, and the right screenshot shows the 'cylinder' dropdown selected.

**Left Screenshot (projections selected):**

Property	Value	Unit
Projections	projections	
Pipe Length	29.4	m
DX	4.345597	m
DY	-29.07707	m
DZ	0	m
Outer Diameter	530	mm
Wall Thickness	8	mm
Material	API-5L X52	
Pressure	L 6.38	kgf/sq.cm
Temperature	L 14	°C
Test Pressure	7	kgf/sq.cm
Pipe Weight	102.99	kgf/m
Insulation	L 0	kgf/m
Fluid	L 18.34	kgf/m
Fluid Density	L 88.39	kg/m3

**Right Screenshot (cylinder selected):**

Property	Value	Unit
Projections	cylinder	
Length in XY plane	29.4	m
DZ	0	m
Angle With X Axis	+ 81.5	°
Angle With Y Axis	- 8.5	°
Outer Diameter	530	mm
Wall Thickness	8	mm
Material	API-5L X52	
Pressure	L 6.38	kgf/sq.cm
Temperature	L 14	°C
Test Pressure	7	kgf/sq.cm
Pipe Weight	102.99	kgf/m
Insulation	L 0	kgf/m
Fluid	L 18.34	kgf/m
Fluid Density	L 88.39	kg/m3



PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE

# PASS/Start-Prof | Piping Model Creation

## Bend Object



Material	Material	Size	Angle	Diameter	DN	NPS	Schedule	Thickness	Min Substrate	Min Substrate	Min Substrate	Radius	Weight	Ovalization	Radius Type	Standard	
Forged Elbow	ASME B16.9-2012	Forged Elbow	90-ELB	88	90.3	30	2	160	0	0	0	0	15	0.5	0	long	ASME
Forged Elbow	ASME B16.9-2012	Forged Elbow	90-ELB	88	90.3	30	2	95	0	0	0	0	15	0.04	0	long	ASME
Forged Elbow	ASME B16.9-2012	Forged Elbow	90-ELB	88	90.3	30	2	160	0	0	0	0	15	1.3	0	long	ASME
Forged Elbow	ASME B16.9-2012	Forged Elbow	90-ELB	88	90.3	30	2	140	0	0	0	0	15	0	0	long	ASME
Forged Elbow	ASME B16.9-2012	Forged Elbow	90-ELB	88	90.3	30	2	125	0	0	0	0	15	0	0	long	ASME
Forged Elbow	ASME B16.9-2012	Forged Elbow	45-75	42	73	63	2	112	0	0	0	0	15	0	0	long	ASME
Forged Elbow	ASME B16.9-2012	Forged Elbow	45-75	42	73	63	2	112	0	0	0	0	15	0	0	long	ASME
Forged Elbow	ASME B16.9-2012	Forged Elbow	45-75	42	73	63	2	112	0	0	0	0	15	0	0	long	ASME
Forged Elbow	ASME B16.9-2012	Forged Elbow	45-75	42	73	63	2	112	0	0	0	0	15	1	0	long	ASME

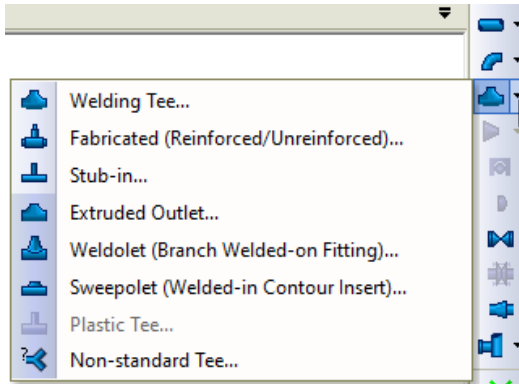
- Forged Elbow...
- Pipe Bend...
- Miter Bend (Closely Spaced)...
- Welding Elbow...
- Long Radius Pipe Bend...
- Prestressed Pipe Bend...
- Miter Joint (Widely Spaced)...
- Non-standard Bend...



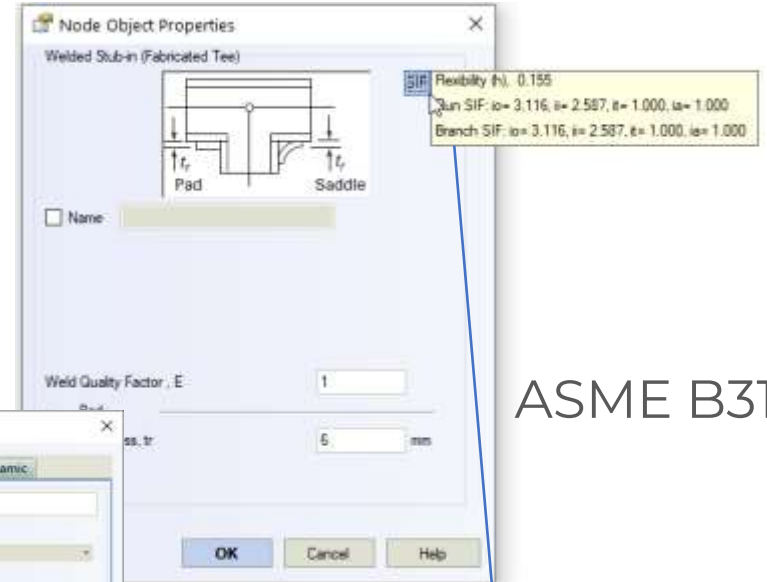
PIPING AND EQUIPMENT ANALYSIS & SIZING SUITE



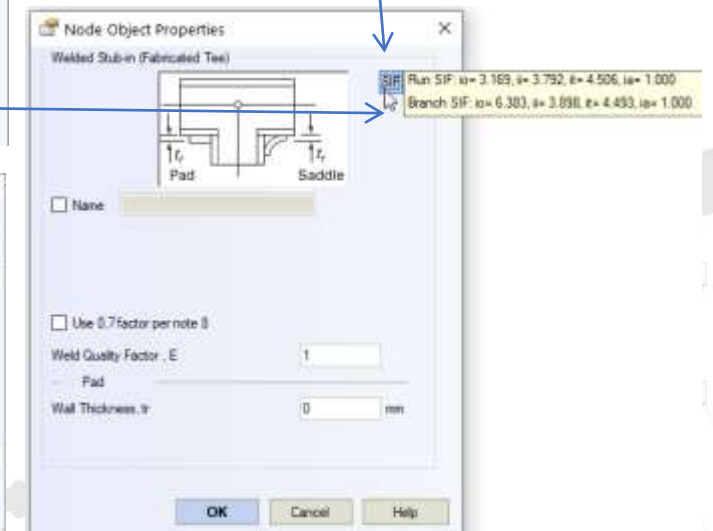
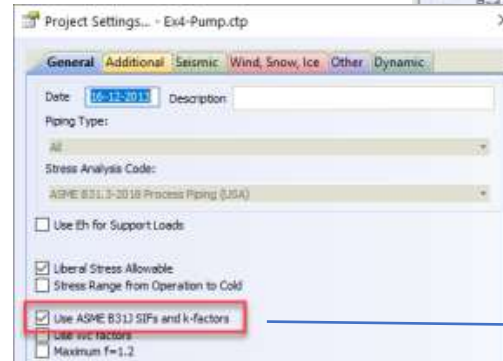
# PASS/Start-Prof | Piping Model Creation



Tee Object



ASME B31J



Tees

Manufacturing Technology	Standard	Material	Size	Header Diameter, mm	Branch Diameter, mm	Header DN, mm	Branch DN, mm	Header SIF, $i_0$	Branch SIF, $i_1$	Schedule	Header Thickness, mm	Branch Thickness, mm	Header SIF Tolerance, mm	Branch SIF Tolerance, mm	Full Length, mm	Crotch Height, mm	Crotch Radius, mm	Weight, kg	Standard Group
Welded Tee	ASME B16.9-2012	Welded Tee	42.2-21.3	42.2	21.3	32	15	1.114	1/2	30	0	0	0	0	96	48	0	0	ASME
Welded Tee	ASME B16.9-2012	Welded Tee	42.2-21.3	42.2	21.3	32	15	1.114	1/2	30	0	0	0	0	96	48	0	0	ASME
Welded Tee	ASME B16.9-2012	Welded Tee	42.2-26.7	42.2	26.7	32	20	1.114	3/4	120	0	0	0	0	96	48	0	0	ASME
Welded Tee	ASME B16.9-2012	Welded Tee	42.2-26.7	42.2	26.7	32	20	1.114	3/4	100	0	0	0	0	96	48	0	0	ASME
Welded Tee	ASME B16.9-2012	Welded Tee	42.2-26.7	42.2	26.7	32	20	1.114	3/4	180	0	0	0	0	96	48	0	0	ASME
Welded Tee	ASME B16.9-2012	Welded Tee	42.2-26.7	42.2	26.7	32	20	1.114	3/4	140	0	0	0	0	96	48	0	0	ASME
Welded Tee	ASME B16.9-2012	Welded Tee	42.2-26.7	42.2	26.7	32	20	1.114	3/4	X95	0	0	0	0	96	48	0	1	ASME
Welded Tee	ASME B16.9-2012	Welded Tee	42.2-26.7	42.2	26.7	32	20	1.114	3/4	70	0	0	0	0	96	48	0	0	ASME
Welded Tee	ASME B16.9-2012	Welded Tee	42.2-26.7	42.2	26.7	32	20	1.114	3/4	70	0	0	0	0	96	48	0	0	ASME

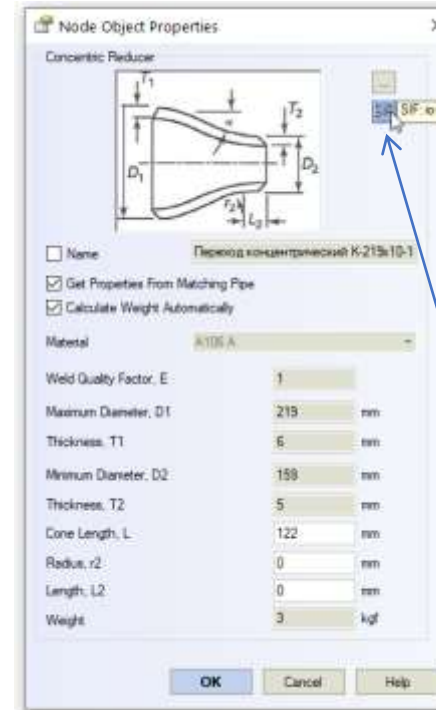
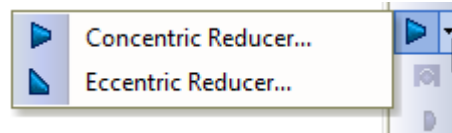
Only first 200 rows are shown. To see other rows, please use filters.

Save Close Help

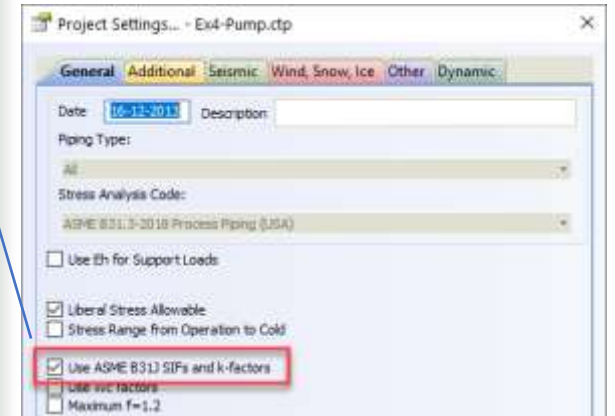


# PASS/Start-Prof | Piping Model Creation

Reducer Object



ASME B31J



Reducers

Type: concentric

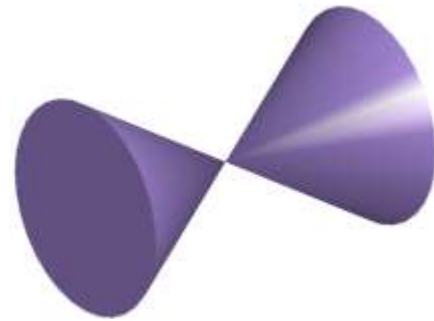
Manufacturing Technology	Standard	Material	Size	Diameter min, mm	Diameter max, mm	Nominal Diameter min, mm	Nominal Diameter max, mm	KPS min, in	KPS max, in	Schedule	Thickness at Dmax, mm	Thickness at Dmin, mm	MIL Tolerance at Dmax, mm	MIL Tolerance at Dmin, mm	Full Length, mm	Cone Length, mm
<next set>	ASME B16.9-2012	<next set>	20-10	25.7	17.5	20	30	3/4	3/8	30	0	0	0	0	38	22.8
<next set>	ASME B16.9-2012	<next set>	20-10	25.7	17.5	20	30	3/4	3/8	35	0	0	0	0	38	22.8
<next set>	ASME B16.9-2012	<next set>	20-10	25.7	17.5	20	30	3/4	3/8	20	0	0	0	0	38	22.8
<next set>	ASME B16.9-2012	<next set>	20-10	25.7	17.5	20	30	3/4	3/8	30	0	0	0	0	38	22.8
<next set>	ASME B16.9-2012	<next set>	20-10	25.7	17.5	20	30	3/4	3/8	35	0	0	0	0	38	22.8
<next set>	ASME B16.9-2012	<next set>	20-10	25.7	17.5	20	30	3/4	3/8	405	0	0	0	0	38	22.8
<next set>	ASME B16.9-2012	<next set>	20-10	25.7	17.5	20	30	3/4	3/8	120	0	0	0	0	38	22.8
<next set>	ASME B16.9-2012	<next set>	20-10	25.7	17.5	20	30	3/4	3/8	180	0	0	0	0	38	22.8

Only first 300 rows are shown. To see other rows please use filters.



# PASS/Start-Prof | Piping Model Creation

Valve Object



Node Object Properties

Valve

Name

Length  mm

Weight  lbf

Flange Leakage Check

Leakage Check Method

Flange Code

Gasket Effective Diameter, G  mm

Nominal Pressure PN / Class

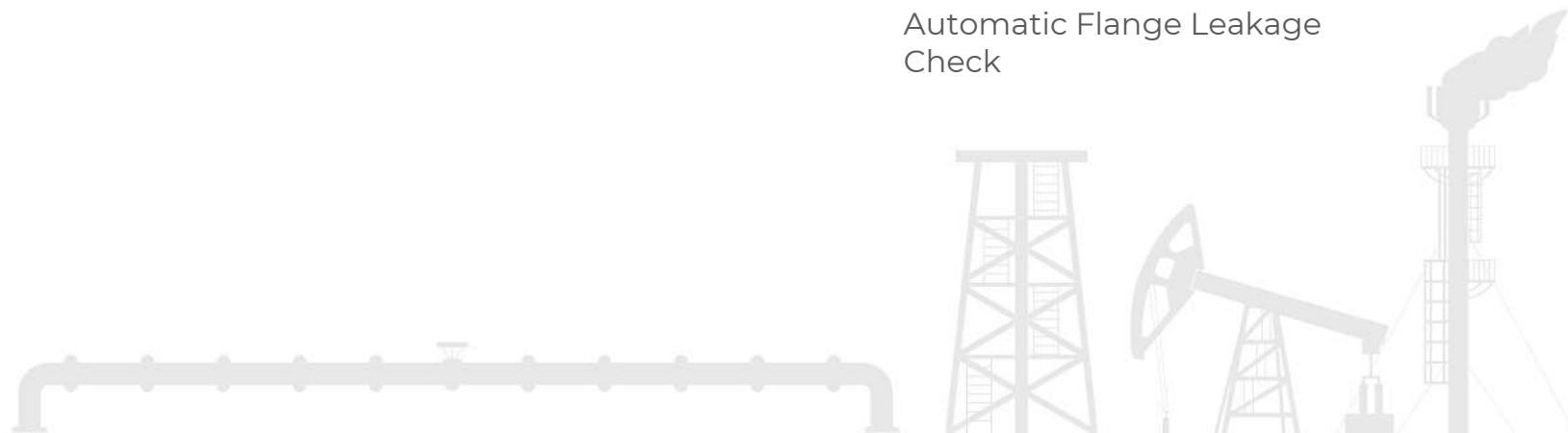
Material Group

OK Cancel Help

Automatic Flange Leakage Check

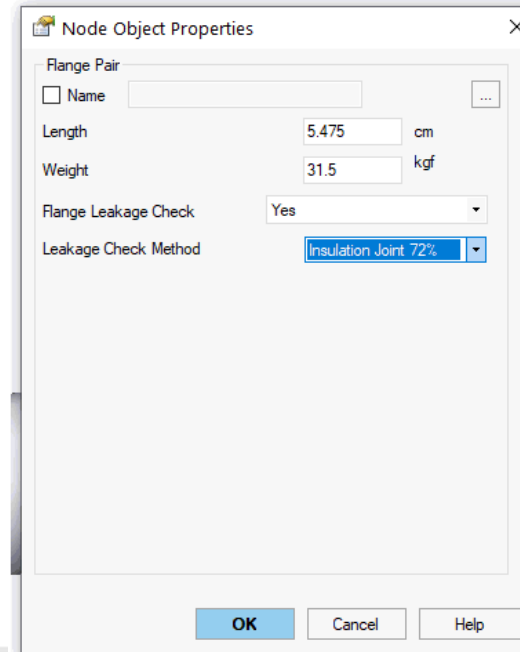
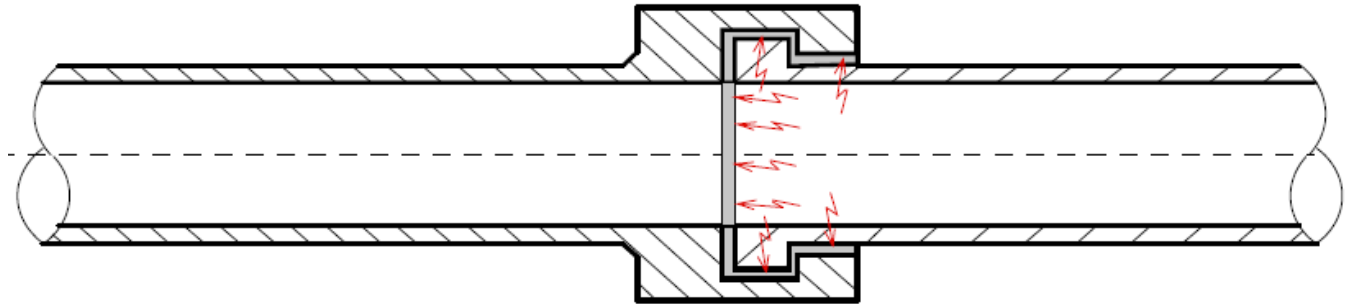


PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE

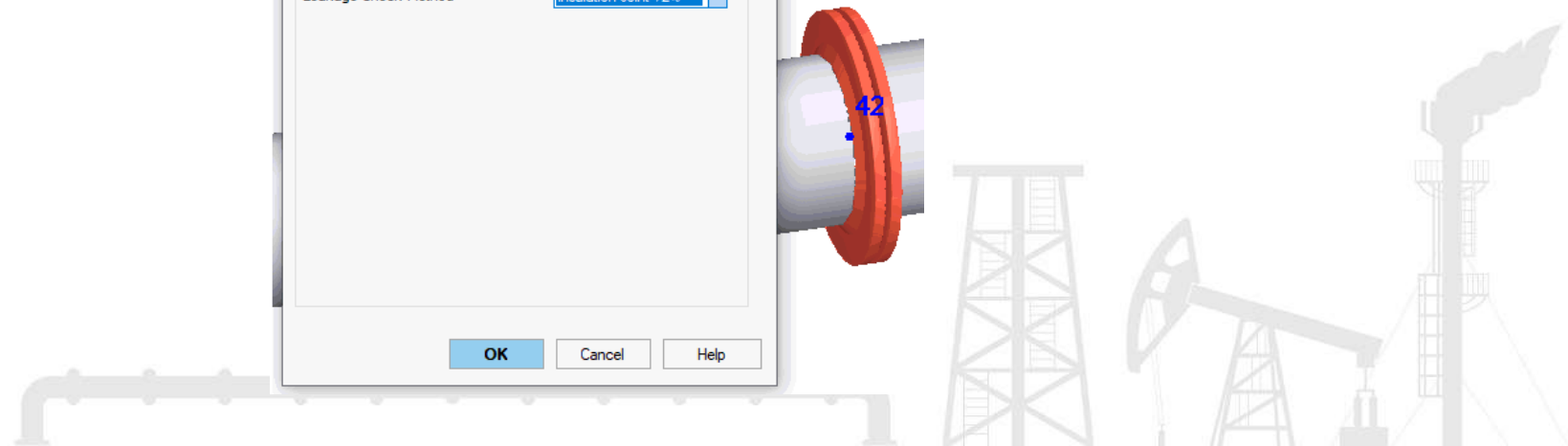


# PASS/Start-Prof | Piping Model Creation

Insulation Joint (Electrical Insulation Kit) Object. The axial stress and stress from torsion moment is checked automatically

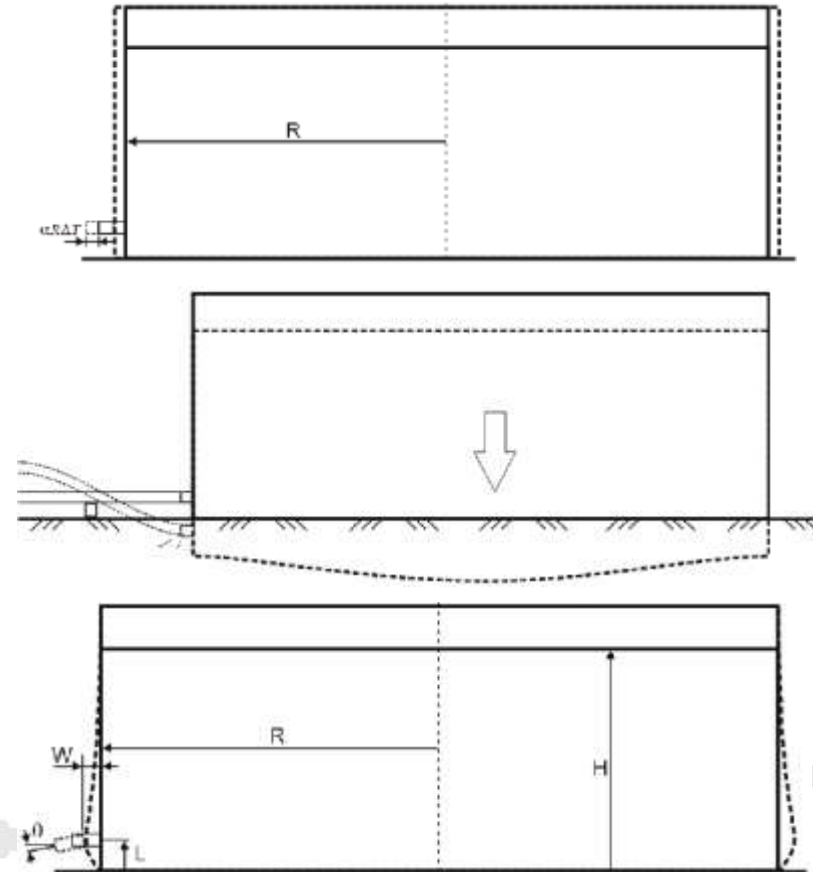
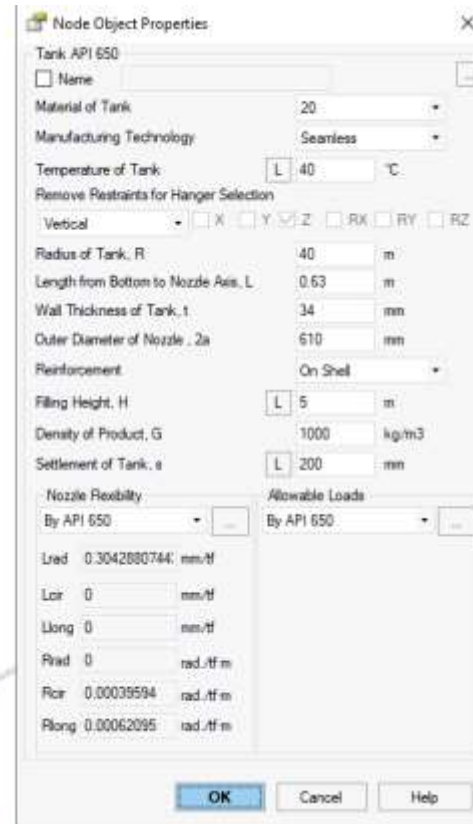
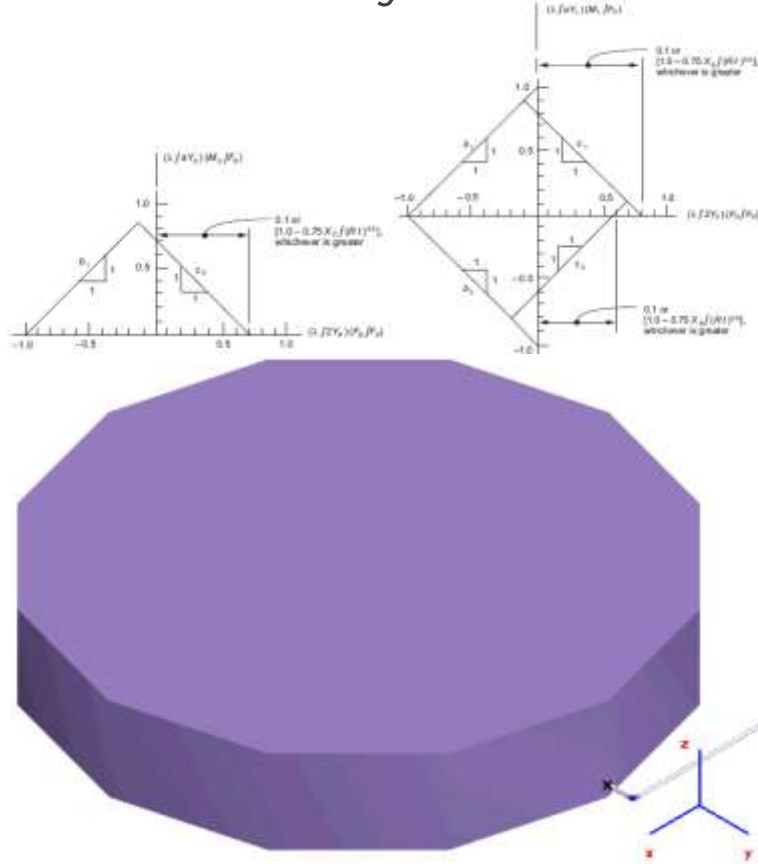


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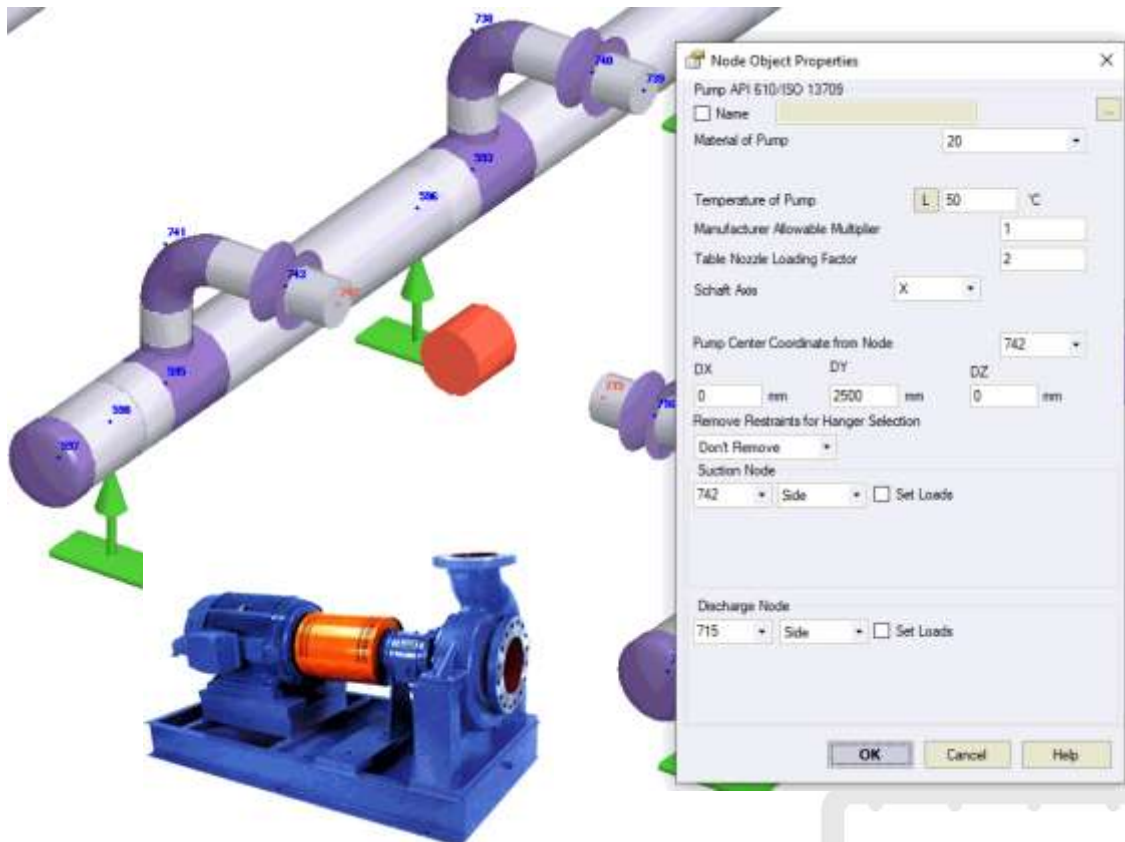
# PASS/Start-Prof | Piping Model Creation

Object "Tank Nozzle API 650", allows to automatically model the storage tank nozzles. Automatically model flexibilities using API 650, thermal movements of the nozzle, movements and rotation due to tank bulging effect using API 650, tank settlement, automatically checks allowable loads using API 650 and STO-SA 03-002-2009



# PASS/Start-Prof | Piping Model Creation

- Object "Pump API 610/ISO 13709", allows to automatically model the pumps, consider thermal movements of the nozzles, checks allowable loads using API 610 and ISO 13709
- Object "Pump ISO 9905", "Pump ISO 5199"
- etc.



- a) The individual component forces and moments acting on each pump nozzle flange shall not exceed the range specified in Table 5 (T4) by a factor of more than 2.
- b) The resultant applied force ( $F_{RCA}$ ,  $F_{RDA}$ ) and the resultant applied moment ( $M_{RCA}$ ,  $M_{RDA}$ ) acting on each pump-nozzle flange shall satisfy the appropriate interaction equations as given in Equations (F.1) and (F.2):

$$\|F_{RCA}\|(1.5 \times F_{R2A}) + \|M_{RCA}\|(1.5 \times M_{R2A}) < 2 \quad (F.1)$$

$$\|F_{RDA}\|(1.5 \times F_{R2D}) - \|M_{RDA}\|(1.5 \times M_{R2D}) < 2 \quad (F.2)$$

- c) The applied component forces and moments acting on each pump nozzle flange shall be translated to the centre of the pump. The magnitude of the resultant applied force,  $F_{RCA}$ , the resultant applied moment,  $M_{RCA}$ , and the applied moment shall be limited by Equations (F.3) to (F.5). (The sign convention shown in Figures 21 through 25 and the right-hand rule should be used in evaluating these equations.)

$$F_{RCA} < 1.5(F_{R2A} + F_{R2D}) \quad (F.3)$$

$$M_{RCA} < 2.0(M_{R2A} + M_{R2D}) \quad (F.4)$$

$$M_{RCA} < 1.5(M_{R2A} + M_{R2D}) \quad (F.5)$$

where

$$F_{RCA} = \sqrt{F_{XCA}^2 + F_{YCA}^2 + F_{ZCA}^2}$$

where

$$F_{XCA} = F_{X2A} + F_{X2D}$$

$$F_{YCA} = F_{Y2A} + F_{Y2D}$$

$$F_{ZCA} = F_{Z2A} + F_{Z2D}$$

$$M_{RCA} = \sqrt{M_{XCA}^2 + M_{YCA}^2 + M_{ZCA}^2}$$

where

$$M_{XCA} = M_{X2A} + M_{X2D} - (F_{Y2A}X_2) - (F_{Y2D}X_2) - (F_{Z2A}Z_2) - (F_{Z2D}Z_2)/1000$$

$$M_{YCA} = M_{Y2A} + M_{Y2D} + (F_{X2A}X_2) + (F_{X2D}X_2) - (F_{Z2A}X_2) - (F_{Z2D}X_2)/1000$$

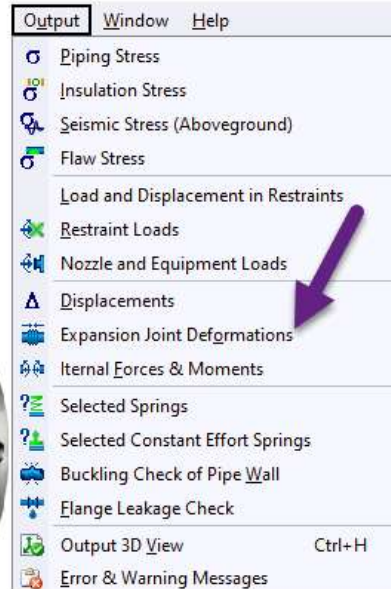
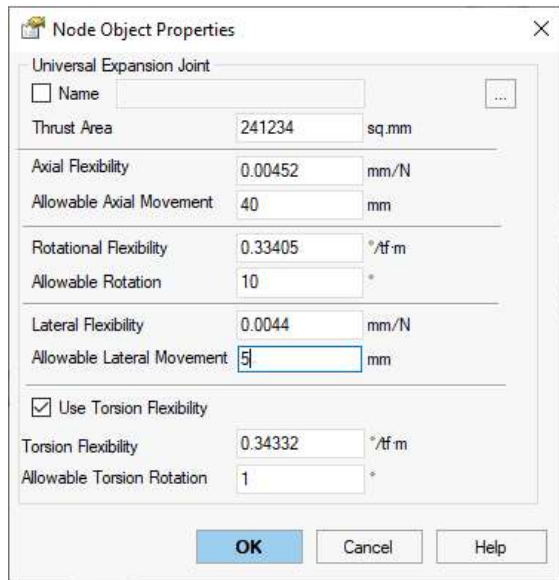
$$M_{ZCA} = M_{Z2A} + M_{Z2D} - (F_{X2A}X_2) - (F_{X2D}X_2) - (F_{Y2A}X_2) - (F_{Y2D}X_2)/1000$$

Object	Start End node	Type	DN, mm	Frod, N	Fcir, N	Flong, N	FR, N	Mrad, N-m	Mcir, N-m	Mlong, N-m	MR, N-m	Sum	Notes
Pump API 610/ISO 13709	Node (1)	Suction, Side	200	-7333	5887	-29592	31050	-2626.53	18306.88	4598.20	19057.39	2.84	1
				9780	6220	7560	6920	3520	5160	7060	4710		
	Node (3)	Discharge, Side	200	1440505	-173	0	1440505	0	28.89	28.89	28.89	69.39	1
				9780	6220	7560	6920	3520	5160	7060	4710		
		Summary Loads		1433173	5714	-29592	1433490	-2626.53	33102.90	7657.21	34078.35		1
							29760						

[My\_sum]=2([MradT1]) + ([MradT2])=2\*(1760+1760)=7040 N-m

# PASS/Start-Prof | Piping Model Creation

Added new object Untied Expansion Joint and database of Untied Expansion Joints, allows to specify the axial, rotational, shear and torsion flexibility and automatically checks the individual and combined allowable deformations. No need to manually model it using nonstandard expansion joint any more



$$\frac{|\lambda_p|}{[\lambda_p]} + \frac{|\lambda_\theta|}{[\lambda_\theta]} + \frac{|\lambda_\Delta|}{[\lambda_\Delta]} \leq 1.$$

Node Number	Type	Local axis	Axial, (mm)	Allowable, (mm)	Shear, (mm)	Allowable, (mm)	Angular, (°)	Allowable, (°)	Torsion, (°)	Allowable, (°)	Summary	Notes
12	Untied Expansion Joint	Pipe 3 - 12	2.41	50	1.22	15	9.59131	10	-2.05119	No	1.09	1
13	Torsion Expansion Joint	Pipe 5 - 13	0	No	0	No	0	No	13.9229	51.5662	0.27	
15	Torsion Expansion Joint	Pipe 7 - 15	0	No	0	No	0	No	10.1299	51.5662	0.20	
21	Torsion Expansion Joint	Pipe 19 - 21	0	No	0	No	0	No	-4.36021	51.5662	0.08	



PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE

# PASS/Start-Prof | Piping Model Creation

Added new object Torsion Expansion Joint and database of torsion expansion joints, automatically model torsion friction (friction moment) and checks allowable rotation angle

The image displays a software interface for piping model creation, featuring a photograph of a large pipe joint, a technical diagram of a slip-type expansion joint, and two property dialog boxes.

**Node Object Properties - Torsion Expansion Joint**

- Name
- Friction Moment: 0 kgf·cm
- Allowable Rotation: 0
- Buttons: OK, Cancel, Help

**Node Object Properties - Slip Joint**

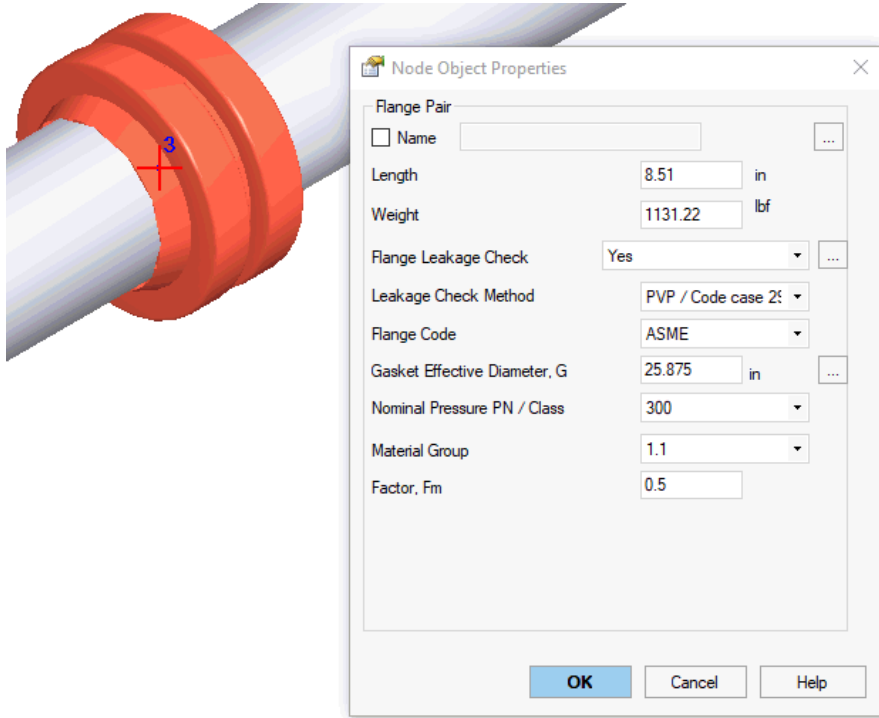
- Name
- Friction Force: 0 kgf
- Allowable Axial Expansion: 0 mm
- Pressure Balanced
- Buttons: OK, Cancel, Help

The technical diagram, titled "SLIP-TYPE EXPANSION JOINT", shows two pipes: "Pipe 1 slides in pipe 2". It includes labels for "Flange bolts", "Packing", and "Pressure + moment". Force equations are provided:  $F = pA + mV$  and  $F = pA + mV$ . A 3D model of a blue pipe joint is also shown.



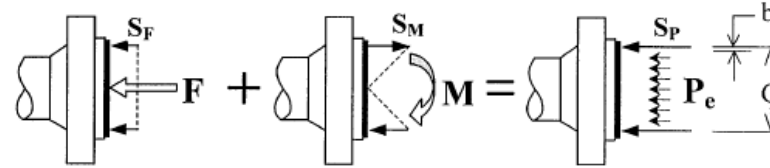
# PASS/Start-Prof | Piping Model Creation

## Flange Object



### Automatic Flange Leakage Check:

- Equivalent pressure / Kellogg Method
- Code Case 2901 / PVP2013-97814 Method
- DNV Method
- NC 3658.3 Method



Input Flange leakage

Operating Mode: 1 'Operation mode' (0) Submode: Operation (all loads)

Node Number	Object	Flange on the side of node	Pipe outside diameter, (mm)	Temperature, (°C)	Axial Force, (kgf)	Bending Moment, (kgf-m)	Parameters	Condition, (MPa)			Notes
								calculated	allowable	%	
3	Flange Pair	-	219.08	400	-1000	1499.98	1.60 MPa	4.29 MPa	17.36 MPa	24.70	

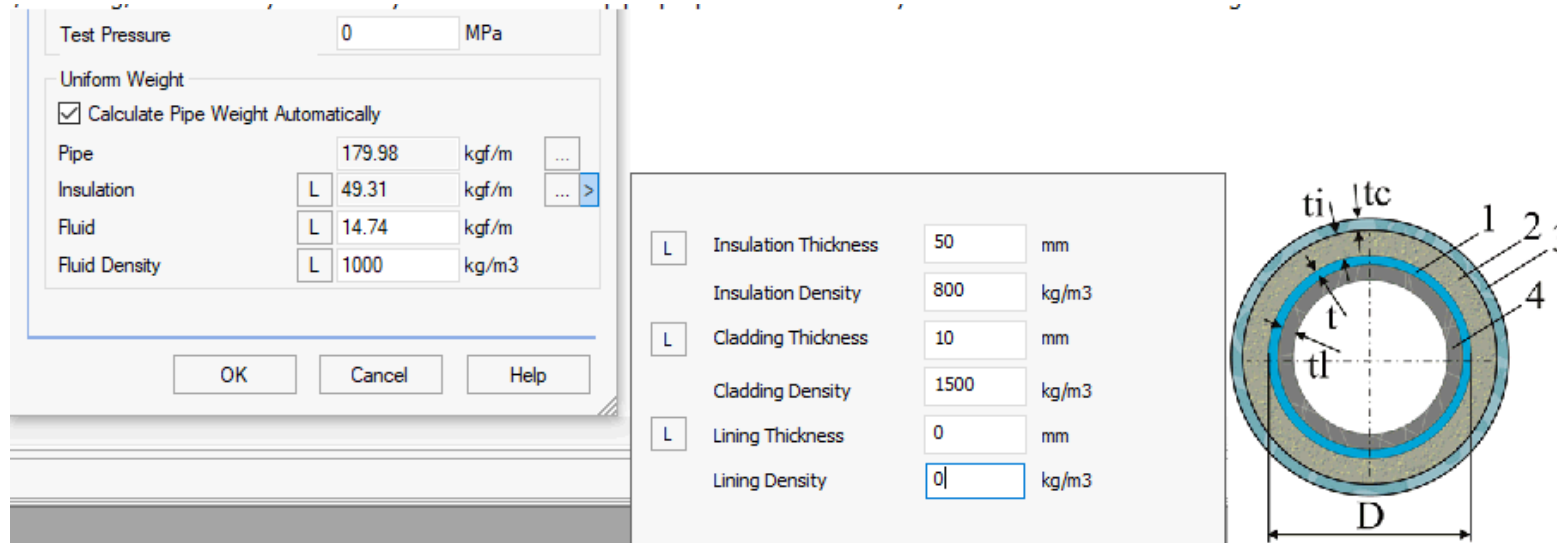


PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE



# PASS/Start-Prof | Piping Model Creation

Added ability to specify insulation, cladding, and liner layers density and thickness in pipe properties. The ability to choose an insulation weight from the database still exist



The screenshot displays the software interface for defining pipe properties. On the left, a dialog box shows the following settings:

Property	Value	Unit
Test Pressure	0	MPa
Uniform Weight	<input checked="" type="checkbox"/> Calculate Pipe Weight Automatically	
Pipe	179.98	kgf/m
Insulation	L 49.31	kgf/m
Fluid	L 14.74	kgf/m
Fluid Density	L 1000	kg/m <sup>3</sup>

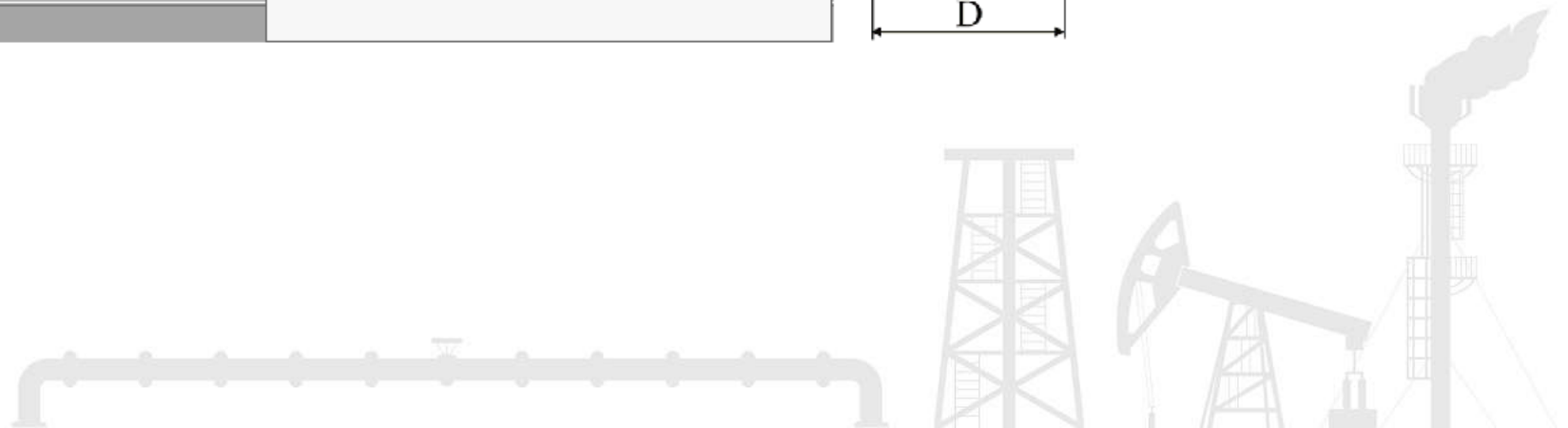
On the right, a detailed property list is shown:

<input type="checkbox"/> Insulation Thickness	50	mm
<input type="checkbox"/> Insulation Density	800	kg/m <sup>3</sup>
<input type="checkbox"/> Cladding Thickness	10	mm
<input type="checkbox"/> Cladding Density	1500	kg/m <sup>3</sup>
<input type="checkbox"/> Lining Thickness	0	mm
<input type="checkbox"/> Lining Density	0	kg/m <sup>3</sup>

To the right of the property list is a cross-sectional diagram of a pipe with diameter  $D$ . The diagram illustrates four layers: 1 (Insulation), 2 (Cladding), 3 (Pipe), and 4 (Lining). Dimensions are labeled as  $t_i$  (Insulation Thickness),  $t_c$  (Cladding Thickness),  $t$  (Pipe Thickness), and  $t_l$  (Lining Thickness).

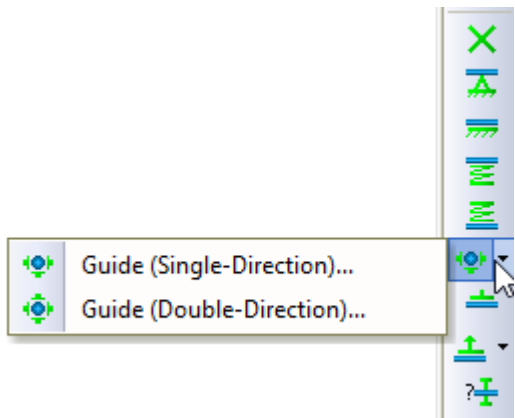


PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE



# PASS/Start-Prof | Piping Model Creation


- Automatic Variable Spring Selection
- Automatic Constant Spring Selection



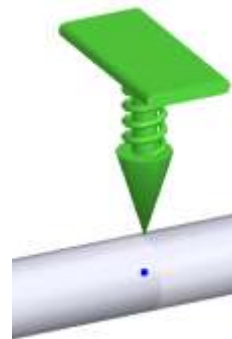
Guide (Single-Direction)...

Guide (Double-Direction)...

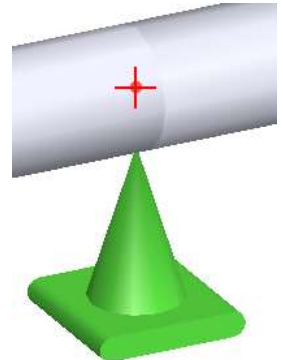
### Anchor



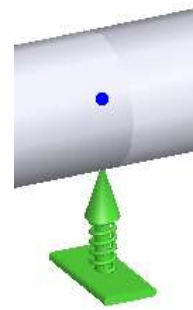
### Spring Hanger



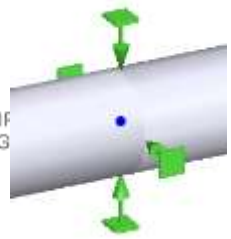
### Hinged Anchor



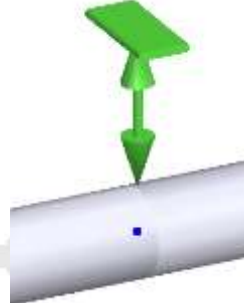
### Spring Support

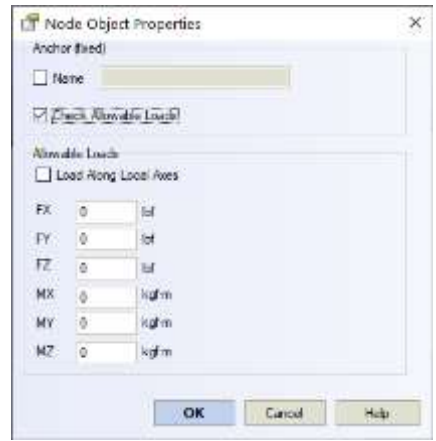


### Guide Support



### Constant Hanger





Node Object Properties

Anchor (fixed)

None

Check Allowable Loads

Allowable Loads

Load Along Local Axes

FX: 0 lbf

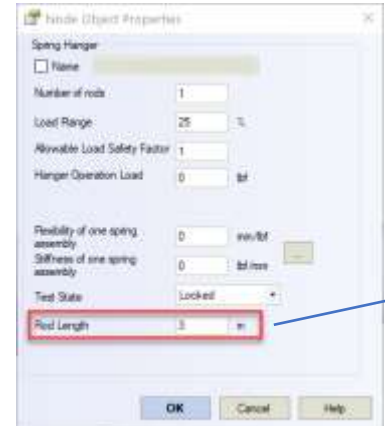
FY: 0 lbf

FZ: 0 lbf

MX: 0 kgfm

MY: 0 kgfm

MZ: 0 kgfm



Node Object Properties

Spring Hanger

Name

Number of rods: 1

Load Range: 25 %

Allowable Load Safety Factor: 1

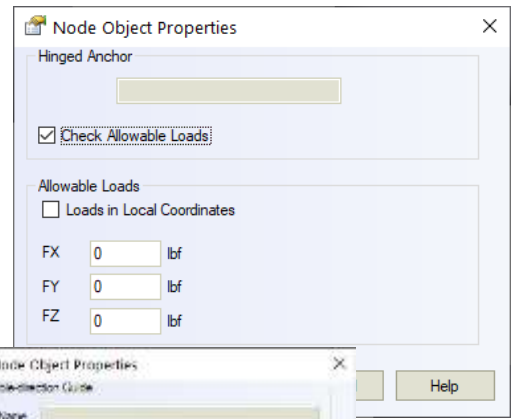
Hanger Operation Load: 0 lbf

Flexibility of one spring assembly: 0 in/lbf

Stiffness of one spring assembly: 0 lbf/in

Test State: Locked

Red Length: 3 in



Node Object Properties

Hinged Anchor

Name

Check Allowable Loads

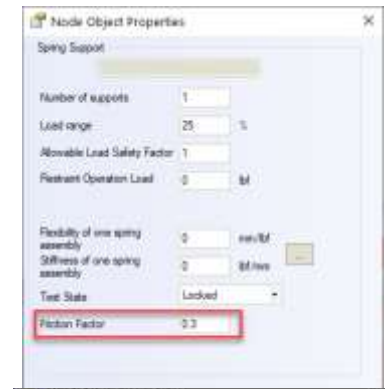
Allowable Loads

Loads in Local Coordinates

FX: 0 lbf

FY: 0 lbf

FZ: 0 lbf



Node Object Properties

Spring Support

Name

Number of supports: 1

Load range: 25 %

Allowable Load Safety Factor: 1


Restraint Operation Load: 0 lbf

Flexibility of one spring assembly: 0 in/lbf

Stiffness of one spring assembly: 0 lbf/in

Test State: Locked

Friction Factor: 0.3



Node Object Properties

Double-direction Guide

Name

Friction Factor: 0.3

Use Gaps

Lateral Gap: 10 mm

Gap (stowage): 10 mm

Check Allowable Loads

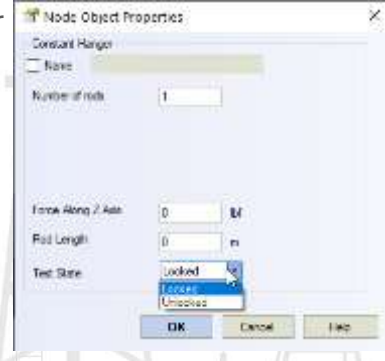
Allowable Loads

Loads in Local Coordinates

FX: 0 lbf

FY: 0 lbf

FZ: 0 lbf



Node Object Properties

Constant Hanger

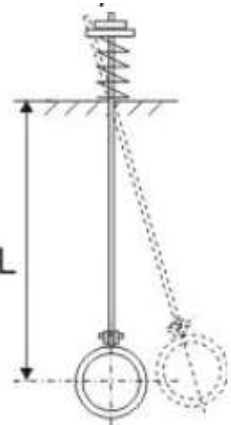
Name

Number of rods: 1

Force Along Z Axis: 0 lbf

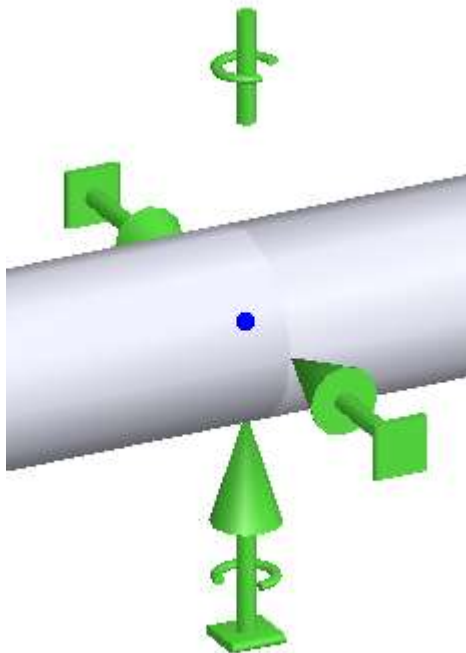
Rod Length: 0 in

Test State: Locked



# PASS/Start-Prof | Piping Model Creation

## Custom Non-Standard Restraint Object



Non-standard Restraint

Name:

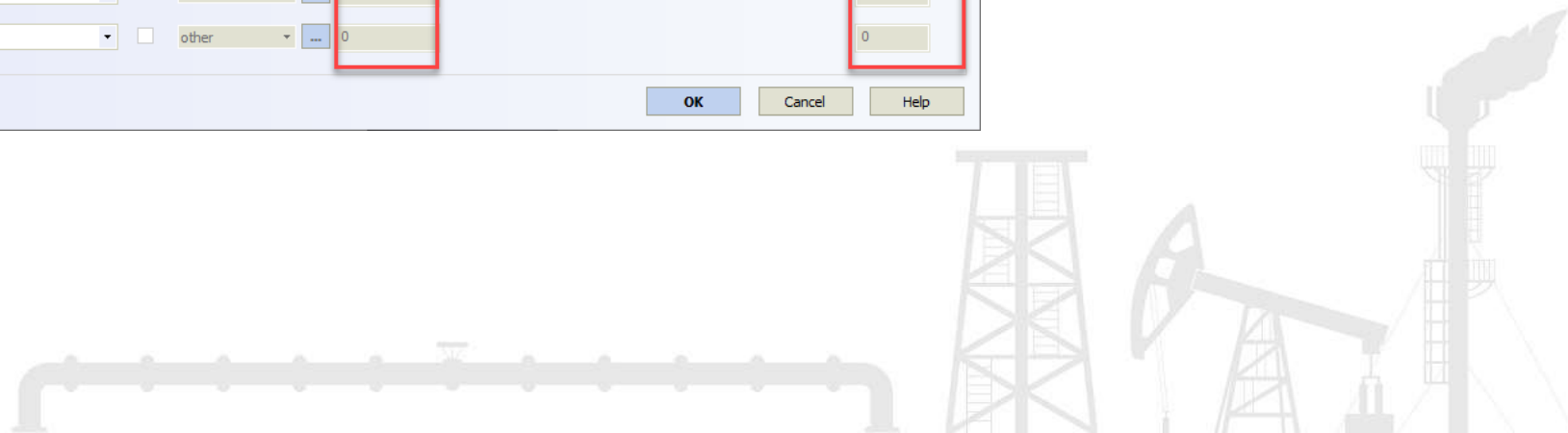
Support N 1    Precompression Spring, X: 0 lbf    Test State: Unlocked    Local Axes of the Pipe: Pipe 31-52  
Precompression Spring, Y: 0 lbf     Check Allowable Loads  
Precompression Spring, Z: 0 lbf     Use Gaps

Linear restraints								
	Local Axes	Restraint Direction	Flexibility, mm/lbf	Rod Length, m	Frict. Factor	Gap +, mm	Gap -, mm	Allowable Load, lbf
1.	<input checked="" type="checkbox"/>	+Ym Horizontal	0	0	0.3	0	0	0
2.	<input checked="" type="checkbox"/>	-Zm Ver/Horz	0	0	0.3	0	0	0
3.	<input type="checkbox"/>	other	0	0	0	0	0	0

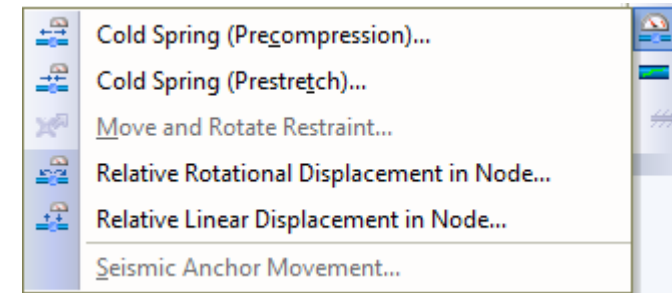
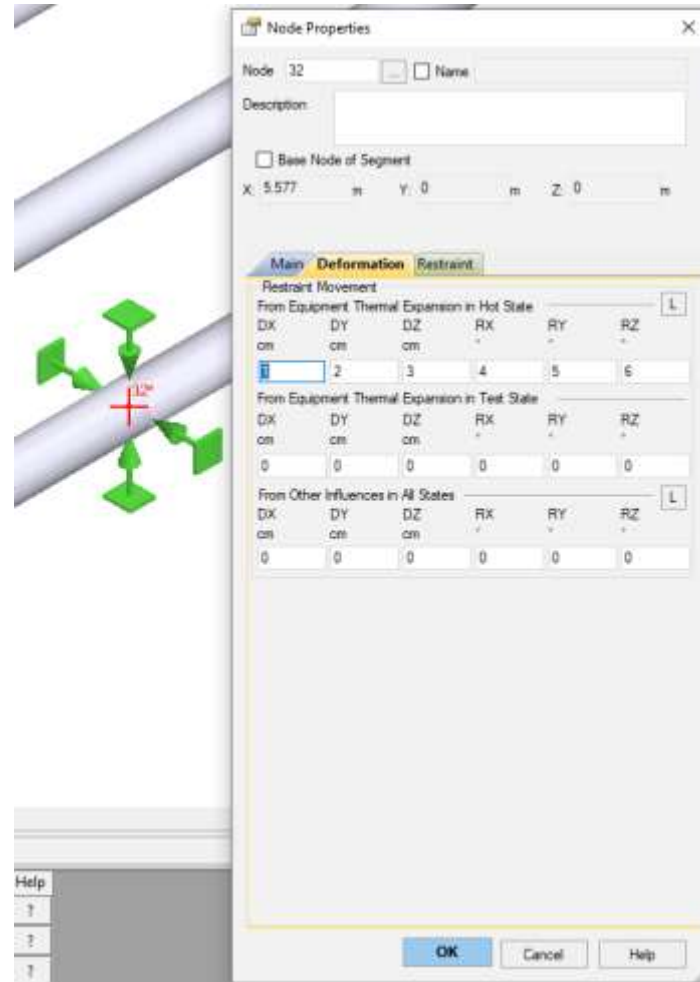
Rotational restraints				
	Local Axes	Restraint Direction Around Axis	Flexibility, °/kgf·m	Allowable Load, kgf·m
4.	<input type="checkbox"/>	+Z	0	0
5.	<input type="checkbox"/>	other	0	0
6.	<input type="checkbox"/>	other	0	0

OK    Cancel    Help



# PASS/Start-Prof | Piping Model Creation

To specify support movement, just add displacement object to the support object

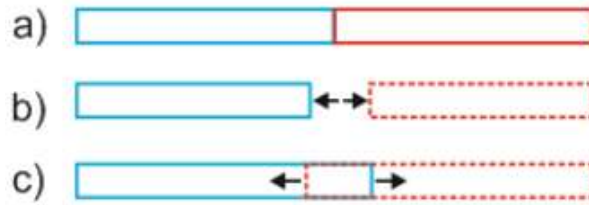
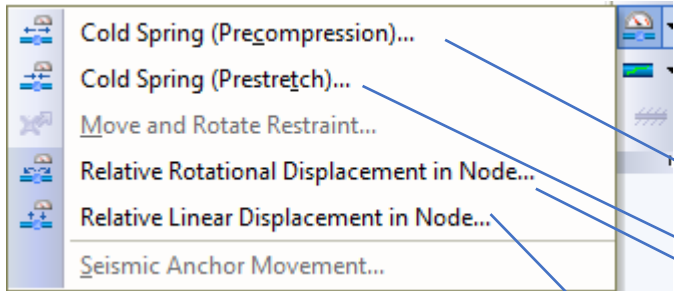


PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE

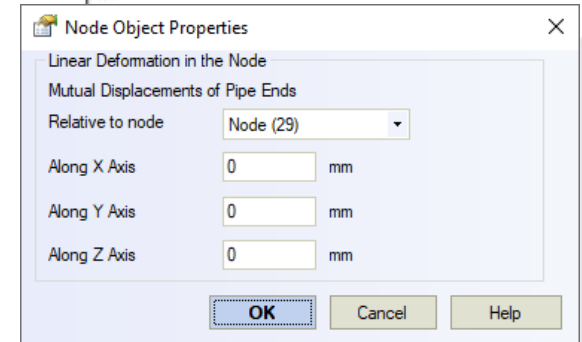
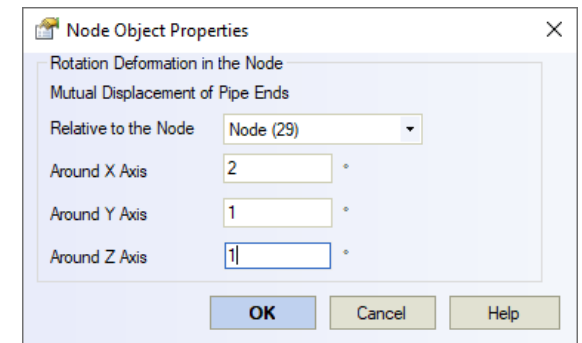
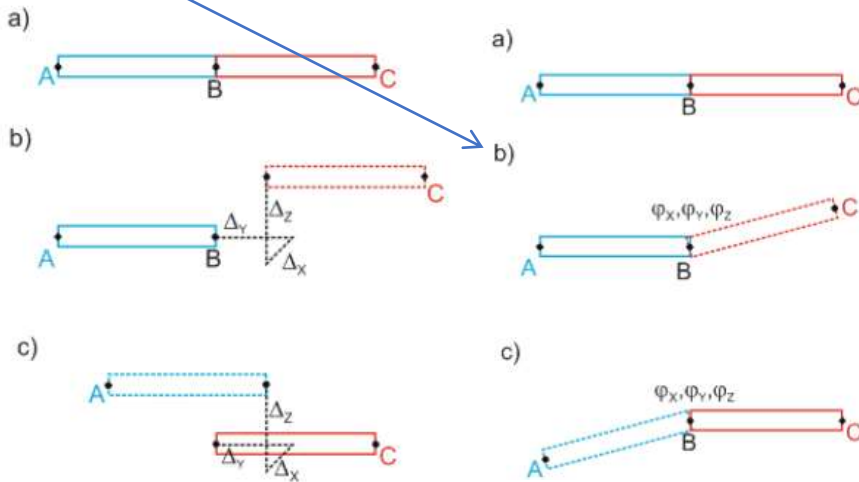
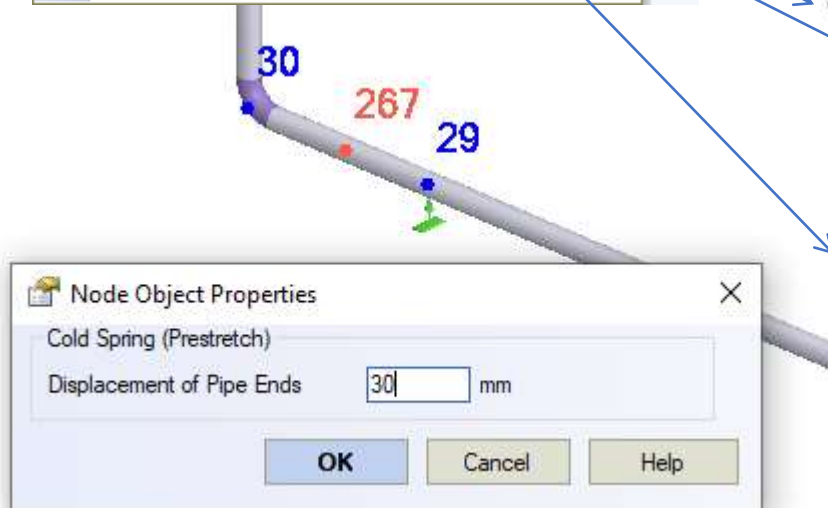


# PASS/Start-Prof | Piping Model Creation

To specify the cold spring (cold pull, pre-stretch), just add the cold spring object in the node



Also pre-compression, and relative rotational or linear displacements of the pipe ends



# PASS/Start-Prof | START-Elements

Pipe wall thickness calculator and bend wall thickness calculator for all codes.

The screenshot displays the Trubodetail1 software interface. It features two overlapping windows. The top window shows input fields for 'Data' (15-06-2020), 'Object Number', 'Code' (ASME B31.8-2018 Gas Transmission (USA)), and a 'Project tree...' pane. The bottom window shows a similar interface but with a scrollable list of codes. The code list includes: ASME B31.8-2018 Gas Transmission (USA), ASME B31.12PL Hydrogen Pipelines (USA), ASME B31.3-2018 Process Piping (USA), ASME B31.4-2019 Pipeline Transportation Syst, ASME B31.5-2016 Refrigeration piping and hea, ASME B31.8-2018 Gas Transmission (USA), ASME B31.9-2014 Building Services Piping (USA), BS PD 8010-1,2:2015 Steel pipelines on Land&, CJJ/T 81-2013 Heating network (China), CSA Z662-19 Oil and gas pipeline systems (Car, DL/T 5366-2014 Power piping (China), EN 13480-2017 Metallic Industrial Piping (Europ, EN 13941-2019 District heating piping systems, GB 50251-2015 Gas Pipelines (China), GB 50253-2014 Oil Pipelines (China), GB 50316-2008 Metallic Industrial Piping (China), GB/T 20801-2006 Process Piping (China), GOST 32388-2013 Process piping (Russia), GOST 32388-2013 Sorting out thicknesses (Ru, GOST 55596-2013 District heating piping syste, GOST R 55989-2014 Gas & oil transmission pipi, GOST R 55990-2014 Oilfield piping system (Rus, ISO 14692-3:2002/Cor 1:2005 GRP piping syst, ISO 14692-3:2017 GRP piping systems (Intern, RD 10-249-98 5.1 Power piping. Barrels, manif, RD 10-249-98 5.2 Power piping. Steam and ho, RD 10-400-01 District heating piping systems (, RTM 38.001-94 Process piping (Russia), SNIP 2.05.06-85 Gas & oil transmission piping s, SP 284.13258000.2016 Oilfield piping system (, SP 33.13330.2012 Steel piping system (Russia).

The right side of the interface contains a parameter table and a diagram. The parameter table includes: Outer Diameter, D (0 mm); Operating Temperature (0 °C); Mill Tolerance (0 %); Corosion Allowance (0 mm); Factor 'E' (1); Factor 'F' (0); Pipeline (Onshore Pipeline); Material (empty); Operating Pressure (0 kgf/sq.cm); and Wall Thickness, S (0 mm). The diagram shows a cross-section of a pipe with diameter D and wall thickness S, with a central point P.

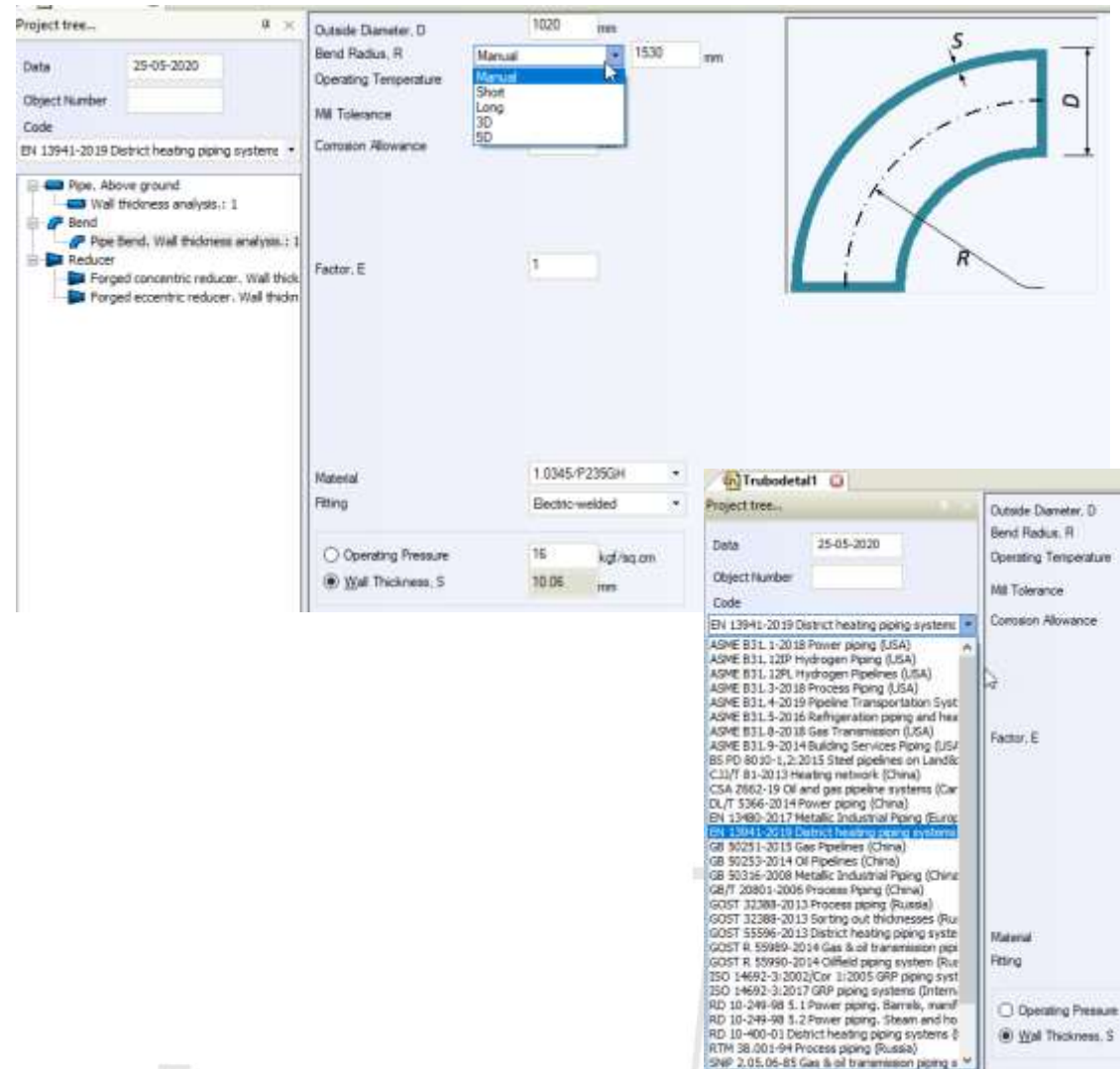


PIPING AND EQUIPMENT  
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# PASS/Start-Prof | START-Elements

Pipe wall thickness calculator and bend wall thickness calculator for all piping codes.

All pipe and fitting wall thicknesses are automatically checked before every run of the pipe stress analysis according to the selected code.



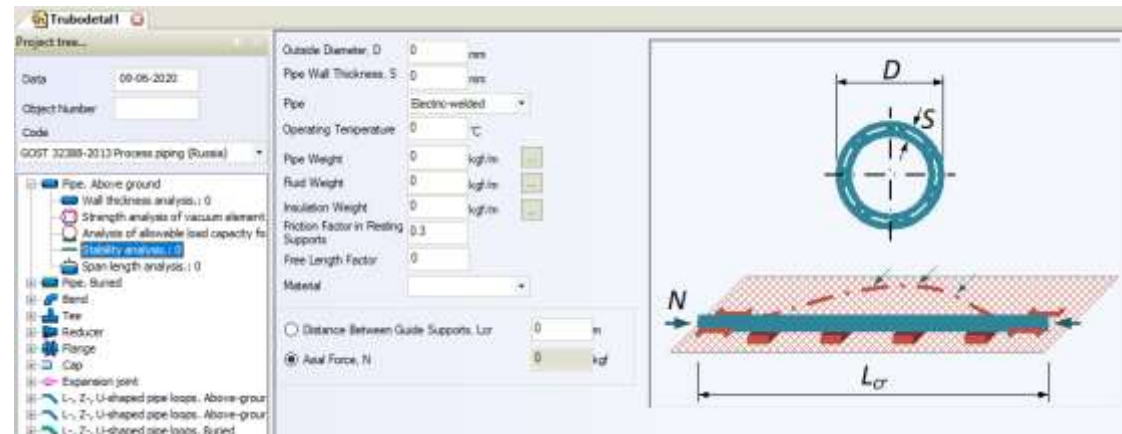
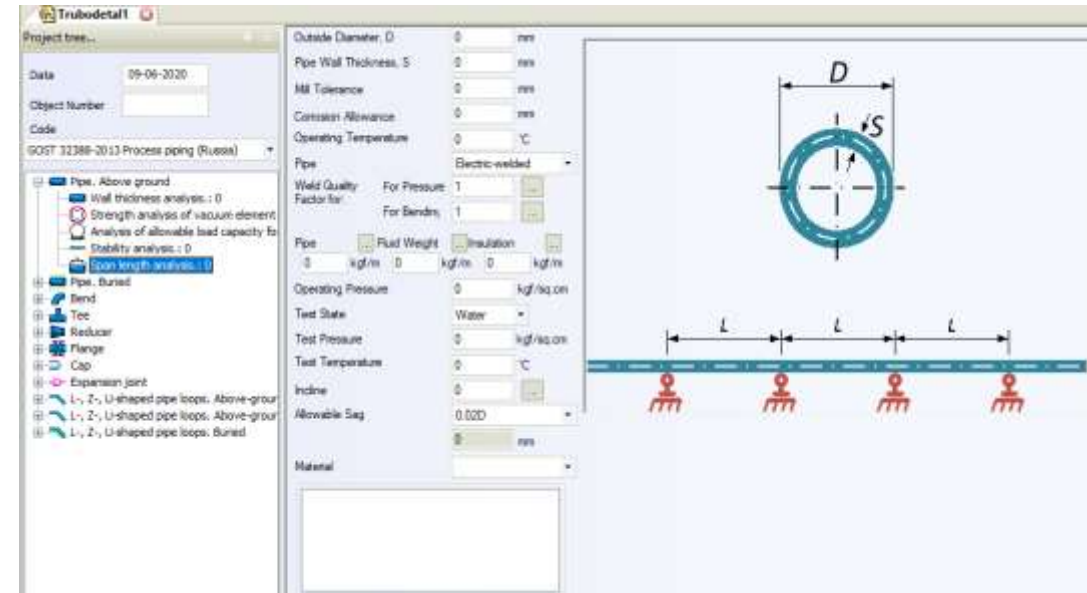
PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE



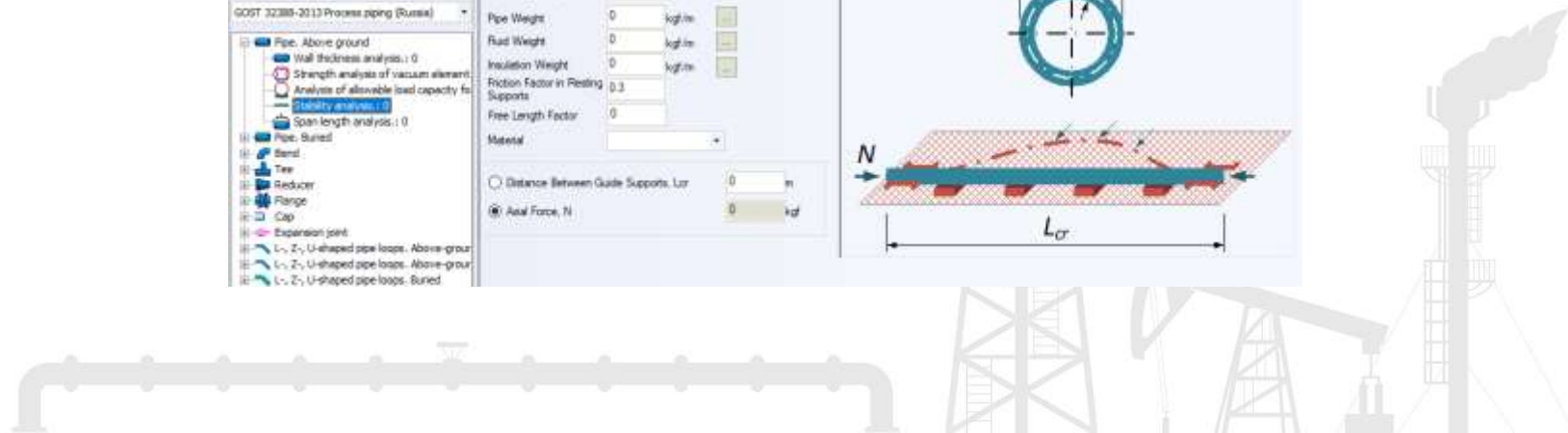
# PASS/Start-Prof | START-Elements

Pipe Span Length Analysis

Longitudinal Stability Analysis



PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE



# PASS/Start-Prof | START-Elements

Calculate Wall Thickness  
Under Vacuum and External  
Loading

Simple Expansion Loop  
Analysis

The image displays two screenshots of the Trubodetail1 software interface. The top screenshot shows the 'Pipe. Above ground' analysis settings. The 'Project tree...' window on the left lists analysis types: Wall thickness analysis, Strength analysis of vacuum element, Analysis of allowable load capacity, Stability analysis, and Span length analysis. The main settings panel includes: Outside Diameter, D (0 mm); Operating Temperature (0 °C); Pipe (Electric-welded); Weld Quality Factor for Pressure (1); Mill Tolerance (0 mm); Corrosion Allowance (0 mm); and an unchecked checkbox for 'Availability of stiffening ribs'. A circular diagram on the right shows a pipe cross-section with diameter D and wall thickness S.

The bottom screenshot shows the 'L-, Z-, U-shaped pipe loops. Above-ground' analysis settings. The 'Project tree...' window lists various loop types: L-shaped, Z-shaped, U-shaped external/internal, and U-shaped nonsymmetric. The main settings panel includes: Pipe Diameter, D (0 mm); Pipe Wall Thickness, S (0 mm); Stretch factor (without stretch - 0) (0); Operating Pressure (0 kgf/sq cm); Material; Expansion joint back, B (0 m); Expansion joint leg, H (0 m); Friction Factor in Resting Supports (0.3); Allowable load on end support (0 kgf); Pipe (Fluid/Insulation); Friction Factor for pressure (1) and bending (0.5); Flexibility of bends (ignore); Bend curve radius (0 mm); and compensated lengths L1 (0 m) and L2 (0 m). A diagram on the right shows a U-shaped expansion loop with dimensions: horizontal span B, vertical height H, radius R, end support distances L1 and L2, and end support points A and B. A circular inset shows the pipe cross-section with diameter D and wall thickness S.



PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE

# PASS/Start-Prof | Features

- No need to create the load cases manually
- Save a lot of time and protect from mistakes
- Operation Mode Editor will do this job for you
- Easy to understand and change
- No limit on pressure, temperature number

67 complex load cases are automatically generated based on simple five START-PROF operating modes

#	Name	High temperature	Cold State	Seismic	Wind	Snow/Ice	Use Load Factors	Friction Multiplier	Weight Multiplier	Mode Type	Stress Range Between
1	Operating	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	1.00	1.00	SUS	1-1A, 1-2, 1-3, 1-4
1.1	Safety Valve Thrust 1	-	-	-	-	-	-	-	-	OCC	-
2	Operating 2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	1.00	1.00	SUS	2-1, 2-1A, 2-3, 2-4
2.1	Safety Valve Thrust 2	-	-	-	-	-	-	-	-	OCC	-
3	Filling	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	1.00	1.00	SUS	3-1A
4	Emergency	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	1.00	1.00	SUS	4-1A
5	Test	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-	-	Test	-

Simplified Load Case Templates. Real load case templates please see in help

Operation Mode #1: Operating

- L1: W1+P1 SUS Stress, Disp, Force, etc.
- L2: W1+P1+T1 OPE Disp, Force, etc.
- L3: L2+L1(≠1) EXP(1-1A) Stress
- L4: L2+L2(≠2) EXP(1-2) Stress
- L5: L2+L2(≠3) EXP(1-3) Stress
- L6: L2+L2(≠4) EXP(1-4) Stress
- L7: W1+P1+T1+5 Disp, Force, etc. (S - Snow)
- L8: L7+L2 Algebraic
- L9: L1+L8 Scalar SUS Stress
- L10: W1+P1+T1+I Disp, Force, etc. (I - Ice)
- L11: L10+L2 Algebraic
- L12: L1+L11 Scalar SUS Stress
- L13: W1+P1+T1 +5Siesmic(+X) Disp, Force, etc.
- L14: L13+L2 Algebraic
- L15: L1+L14 Scalar OCC Stress
- L16: W1+P1+T1 +5Siesmic(-X) Disp, Force, etc.
- L17: L16+L2 Algebraic
- L18: L1+L17 Scalar OCC Stress
- L19: W1+P1+T1 +5Siesmic(+Y) Disp, Force, etc.
- L20: L19+L2 Algebraic
- L21: L1+L20 Scalar OCC Stress
- L22: W1+P1+T1 +5Siesmic(-Y) Disp, Force, etc.
- L23: L22+L2 Algebraic
- L24: L1+L23 Scalar OCC Stress
- L25: W1+P1+T1 +5Siesmic(+Z) Disp, Force, etc.
- L26: L25+L2 Algebraic
- L27: L1+L26 Scalar OCC Stress
- L28: W1+P1+T1 +5Siesmic(-Z) Disp, Force, etc.
- L29: L28+L2 Algebraic
- L30: L1+L29 Scalar OCC Stress
- L31: L1+MAX(L14,L17,...)^0.5 Scalar OCC Stress
- L32: L1+MAX(L14,L17,...)^0.5 Scalar OCC Stress
- L33: L2+MAX(L14,L17,...)^0.5 Disp, Force, etc.

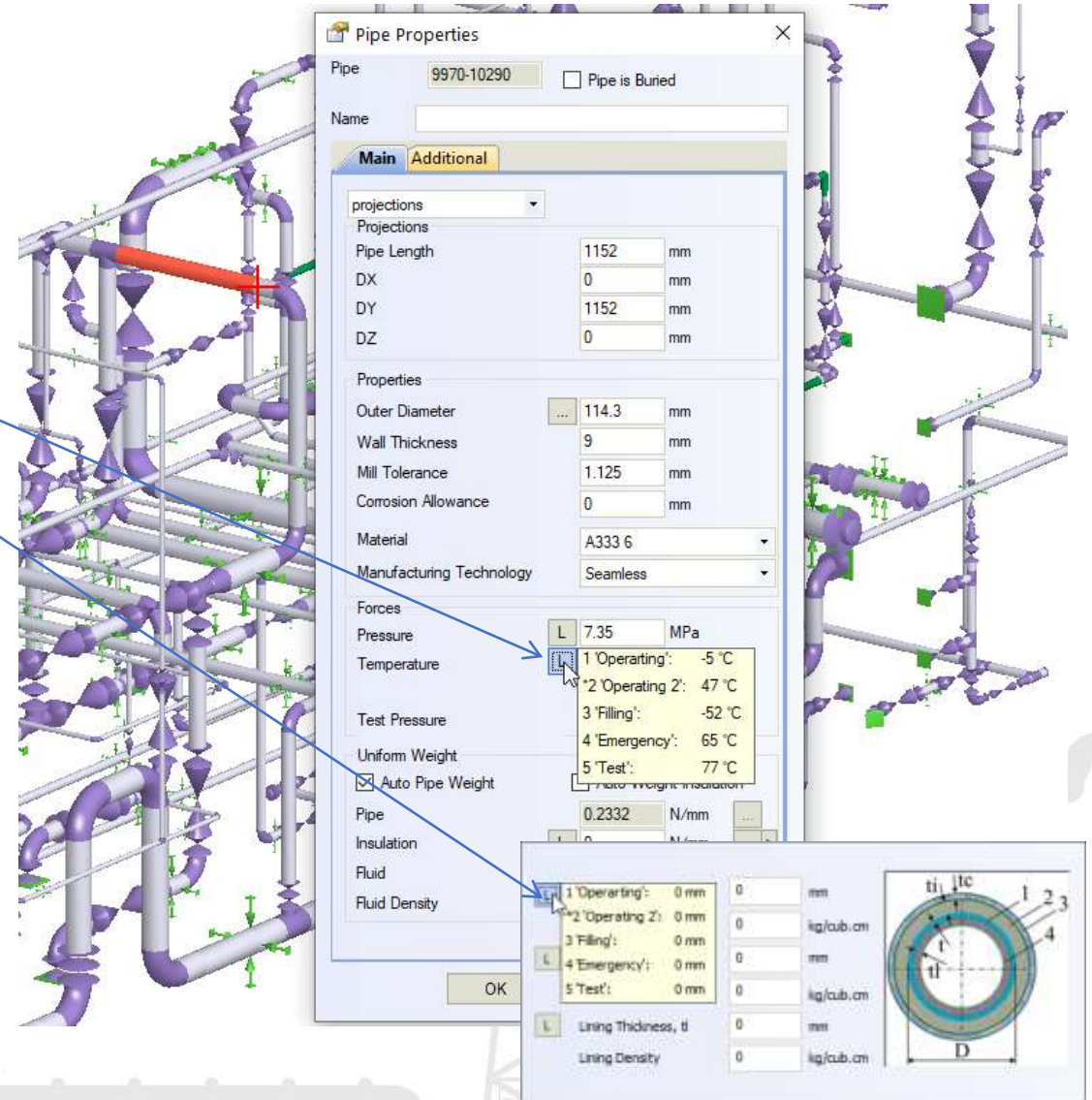


PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE

# PASS/Start-Prof | Features

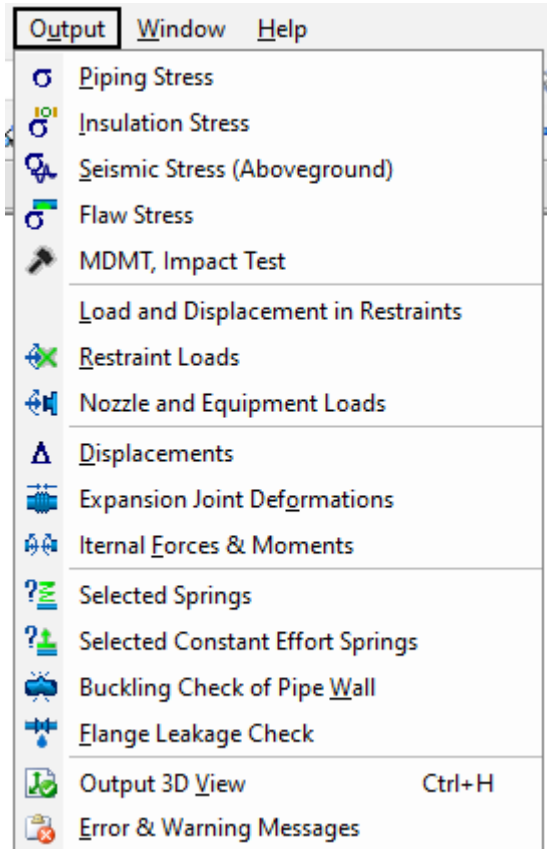
Different operating modes can have different:

- Temperatures 1-∞
- Pressures 1-∞
- Fluid weight 1-∞
- Restraint displacements 1-∞
- Forces and moments, uniform loads 1-∞
- Insulation layers and density, weight 1-∞
- No limit on pressure, temperature, etc. number
- No limit on operation mode number
- Load cases created automatically
- Interactive reports are compiled automatically for all operating modes



# PASS/Start-Prof | Reports

Full scope of the needed interactive reports after analysis



- Reports are interactive. For example, you can add or remove stresses from axial force on-the-fly, change global/local coordinates, add or remove creep stress etc.
- Reports can be copied to MS Excel
- Reports can be exported into MS Word
- Free Viewer is Available  
You can send your piping model to customer, who can open it using viewer and review piping model and all analysis results



PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE



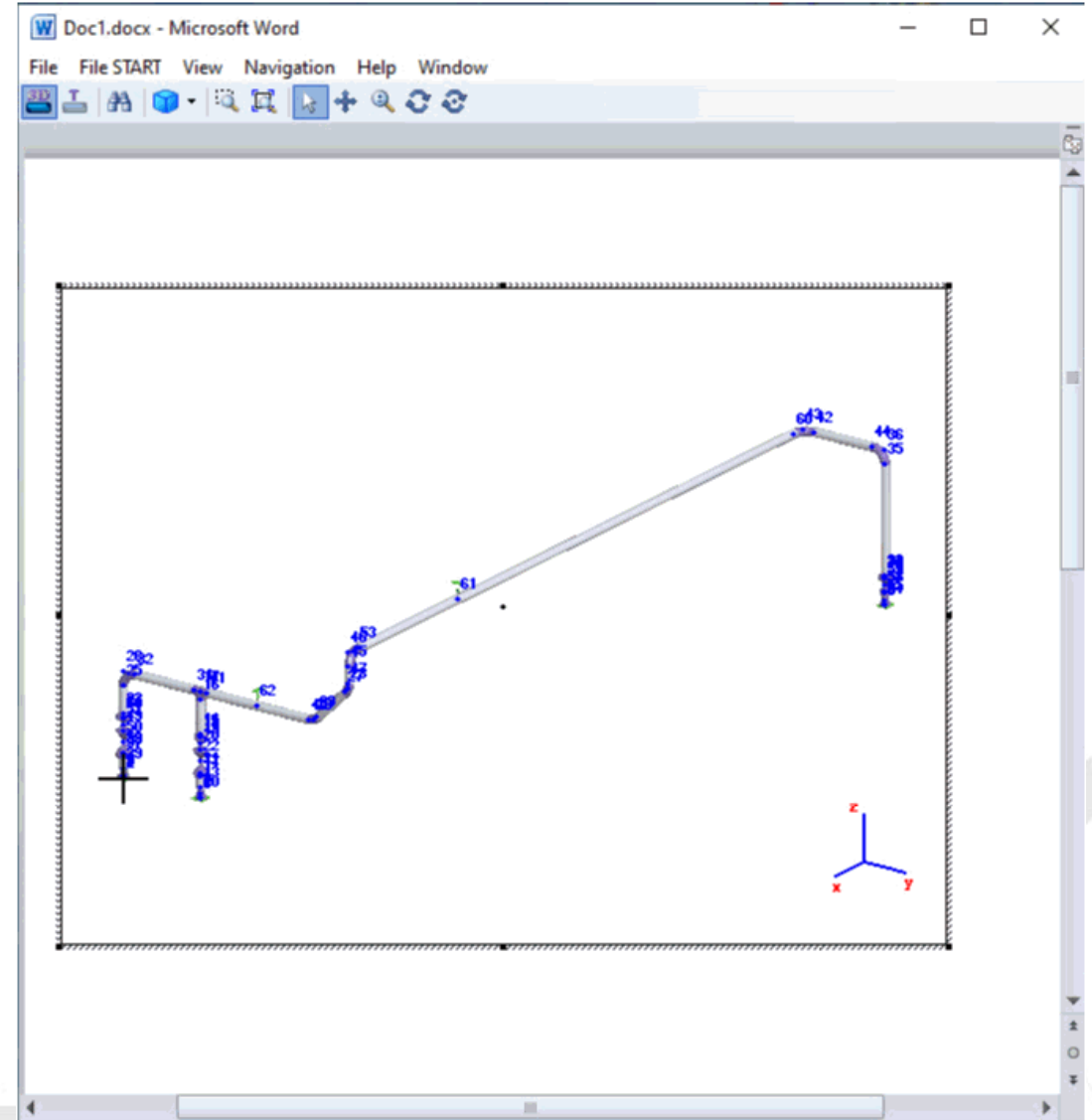
# PASS/Start-Prof | Features

## Function 'Copy Whole Model'.

Allows to copy whole piping model as an object into clipboard. After that you can insert this interactive model into any other software like MS WORD, EXCEL etc.

You can rotate, pan zoom the model right inside MS Word

You can add interactive into report in MS Word and send to your customer for review



PIPING AND EQUIPMENT  
ANALYSIS & SIZING SUITE

# PASS/Start-Prof | Reports

Start-Prof Econom 2017 v.04.82 R2 - [Transfer 55-80 ASME B11.3.ctp - Load on Restraints and Equipment]

File Edit View Service Analysis Output Window Help

Input Loads

Operating Mode: 1 Main (0) | Submode: Operation | Axis: Global axis | Support Type: Anchor fixed; Sliding

Node Number	Type	Forces along coordinate axis, (kgf)			Moments around coord			
		X	Y	Z	X	Y	Z	
2	Console	Anchor (fixed)	0.10	0	-1151.20	0	-575458.38	0.01
3	Restrained	Anchor (fixed)	567378.30	0	-325.80	0	-54294.99	0
4	Restrained	Anchor (fixed)	-567378.30	0	-325.80	0	54295.04	0
5	Bend	Anchor (fixed)	3760.80	556.90	-554.50	-10066.75	-106026.59	-235113.50
7	Bend	Anchor (fixed)	13603.30	-5447.70	-1294.60	-302600.69	9588.95	-1653202.63
9	Anchor (fixed)		-3902.60	2185.80	-720	75899.34	237117.89	209446.26
11	Anchor (fixed)		-287.60	-131	-403	-83205.50	114312.74	54883.24
13	Sliding Support		-71.90	-102	-814.10	0	0	0
15	Anchor (fixed)		96.20	151.30	-486.60	25559.60	-32059.35	42000.25
17	Anchor (fixed)		126.90	247.60	-422.20	63066.41	-52465.34	34842.89
19	Anchor (fixed)		11.10	383.20	-348.40	116306.95	-26298.11	26298.48
21	Anchor (fixed)		-13362.30	2155.90	-543.80	-55819.34	112108.12	407537.56

Properties

Pipe (1-2)

Main

Start Node: 1  
End Node: 2

Name: Projections

Input Type: Projections

Projections/a: 3000 mm, 0 mm

Diameter x T: 219.1 mm X 8.18

Pipe Material: 20

Mill Toleranc: 12.50

Corrosion All: 0 mm

Operating Pr: 1 MPa

Test Pressure: 1.5 MPa

Operating Te: 100 °C

Uniform Wes: Yes, 0.4167975 N

Additional

Longitudinal: 1.00

Circumferent: 1.00

Additional Lc: 0 N/mm, 0 N/mm

Error and warning messages

Type	Node/pipe	Description
Notes	Node:1	(N265) Failed the stress check from pressure and weight loads (1, 'Main')
Notes	Node:5	(N265) Failed the stress check from pressure and weight loads (1, 'Main')
Notes	Node:8	(N284) Failed the fatigue strength check (1, 'Main')
Notes	Node:8	(N284) Failed the fatigue strength check (1, 'Main')
Notes	Node:8	(N268) Failed the stress check in operation condition (1, 'Main')
Notes	Node:8	(N268) Failed the stress check in operation condition (1, 'Main')

Pipes list | Error and warning messages

Для справки нажмите F1

Restraint Loads

START-PROF 04.82 R1 - [START1.ctp - Displacement]

File Edit View Service Analysis Output Window Help

Input Displ

Operating Mode: 1 Main mode | Submode: Operation | Choose Axis: Global axis | Type Filter: Linear | Object Filter: All nodes

Node Number	Type	Displacement along coordinate axis, (mm)		
		X	Y	Z
1	Anchor (fixed)	0	0	0
2	Welding Tee	3	-1.1	-0.4
3	Single-direction Guide	6.1	0	0
4	Forged Elbow	2.8	1.6	1.3
6	Forged Elbow	2.3	-2.2	-0.6
8	Forged Elbow	0.7	-4.9	0.3
9	Sliding Support	0.1	-4	0
10	Anchor (fixed)	0	0	0
12	Spring Hanger	3	1.3	1.4

Properties

Pipe (1-2)

Main

Start Node: 1  
End Node: 2

Name: Projections

Input Type: Projections

Projections/a: 3000 mm, 0 mm

Diameter x T: 219.1 mm X 8.18

Pipe Material: 20

Mill Toleranc: 12.50

Corrosion All: 0 mm

Operating Pr: 1 MPa

Test Pressure: 1.5 MPa

Operating Te: 100 °C

Uniform Wes: Yes, 0.4167975 N

Additional

Longitudinal: 1.00

Circumferent: 1.00

Additional Lc: 0 N/mm, 0 N/mm

Error and warning messages

Type	Node/pipe	Description	Help
Warning	Node:1	(W522) Gap is not considered in the analysis, since it is too small	?
Warning	Node:2	Tee length must be greater than 0	?
Warning	Node:2	(W660) Dummy free end at pipe border may cause analysis inaccuracies if in fact the pipeline continues beyond this point	?
Information	-	(W562) Number of degrees of freedom 13	?

Pipes list | Error and warning messages

Для справки нажмите F1

Displacements

# PASS/Start-Prof | Reports

- Stress report show all used equations
- You can add/remove stress from axial force
- Activate individual features for each pipe stress code
- Cells where the check fails has a red color
- Messages about stress check fail duplicated in the errors and warning window

The screenshot displays the 'Start-Prof Econom 2017 v.04.02 R2 - [Transfer 56-80 ASME B31.3.ctp - Code Stress]' application. The main window shows a 'Stress' report table with columns for 'Stress range', 'Sustained with creep (Operating State)', and 'Sustained with creep (Cold State)'. The table lists various pipe components like 'Above ground pipe', 'Forged Elbow', and 'Welding Tee' with their respective stress values. Several cells in the table are highlighted in red, indicating failed checks. An 'Error and warning messages' window is open at the bottom, showing a list of error messages with columns for 'Type', 'Node/pipe', and 'Description'. The messages are duplicated, showing the same error for multiple nodes. A yellow tooltip is visible over the table, providing detailed information about a specific stress check, including parameters like 'Pressure, 16 kgf/sq.cm' and 'Flexibility Factor (K), 9.690'.

Component	Node	Stress range (kgf/sq.cm)	Sustained with creep (Operating State) (kgf/sq.cm)	Sustained with creep (Cold State) (kgf/sq.cm)	Notes
Above ground pipe	1, Console	187.82	187.82	187.82	
Above ground pipe	2, Console	3998.54	3998.54	3998.54	1,2,7,8,9,10
Above ground pipe	4, Restrained	494.99	472.22	359.55	7,8
Above ground pipe	5, Restrainted	494.99	472.22	359.55	7,8
Forged Elbow	6,0 Flange	703.33	706.01	706.01	1,2,3,7,8
Joint	24	846.33	648.07	648.34	7,8
Above ground pipe	24	846.33	648.07	648.07	7,8
Eccentric Reducer	22	407	407.28	407.28	7,8
Above ground pipe	22	407	407.28	407.28	7,8
Concentric Reducer	23	629.84	629.84	629.84	1,2,7,8
Above ground pipe	23	629.84	629.84	629.84	1,2,7,8
Forged Elbow	5, Bend	1341.3	1345.04	1345.04	1,2,7,8
Above ground pipe	6,0 Flange	1045.3	1049.41	1049.41	1,2,3,7,8
Above ground pipe	8	600.39	552.69	552.69	7,8
Above ground pipe	8	1183.7	614.07	614.07	7,8
Above ground pipe	25	432.12	1208.19	1208.19	1,2,3,7,8
Non-standard bend	25	700.33	484.39	484.39	7,8
Above ground pipe	25	480.45	440.75	440.75	7,8
Above ground pipe	25	480.45	709.99	709.99	3,7,8
Above ground pipe	25	480.45	484.70	484.70	7,8

Type	Node/pipe	Description
Notes	Node:1	(N265) Failed the st
Notes	Node:1	(N265) Failed the st
Notes	Node:1	(N284) Failed the fa
Notes	Node:1	(N284) Failed the fa
Notes	Node:1	(N268) Failed the st
Notes	Node:1	(N268) Failed the st





# PASS/Start-Prof | Reports

PASS/START-PROF has smart warnings in error checker.

It show all engineering warnings like support is lifting off, support loads are greater than allowable, expansion joint deformation exceed the limits, buckling analysis failed, flange leakage failed, spring hanger variable range greater than 25%, spring load in one of load cases is greater than allowable, rod rotation exceed the limit and many others.

The screenshot displays the PASS/Start-Prof software interface. On the left, a 'Properties' panel shows details for 'Node: 234'. The main window shows a 3D model of a piping system with various supports and loads. A purple arrow points from the 'Error and warning messages' table to the 3D model. The table lists the following messages:

Type	Node/pipe	Description	Help
Notes	Node:127	(W455) Failed the stress check from pressure and weight loads (1, Main mode)	?
Notes	Node:127	(W455) Failed the stress check from pressure and weight loads (2, Test mode)	?
Notes	Node:129	(W582) Restriction on force along axis has been violated O2 (Operating State) - 2, Test mode	?
Notes	Node:129	(W582) Restriction on force along axis has been violated O2 (Cold State) - 1, Main mode	?
Notes	Node:129	(W582) Restriction on force along axis has been violated O2 (Operating State) - 1, Main mode	?
Notes	Node:234	(W305) Pipe is lifted above the support (Operating State) - 2, Test mode	?
Notes	Node:279	(W305) Pipe is lifted above the support (Operating State) - 1, Main mode	?
Notes	Node:279	(W305) Pipe is lifted above the support (Operating State) - 2, Test mode	?
Notes	Node:447	(W305) Pipe is lifted above the support (Operating State) - 1, Main mode	?
Notes	Node:447	(W305) Pipe is lifted above the support (Operating State) - 2, Test mode	?
Notes	Node:815	(W305) Pipe is lifted above the support (Operating State) - 1, Main mode	?
Notes	Node:815	(W305) Pipe is lifted above the support (Operating State) - 2, Test mode	?
Notes	Node:895	(W305) Pipe is lifted above the support (Operating State) - 1, Main mode	?
Notes	Node:895	(W305) Pipe is lifted above the support (Cold State) - 1, Main mode	?



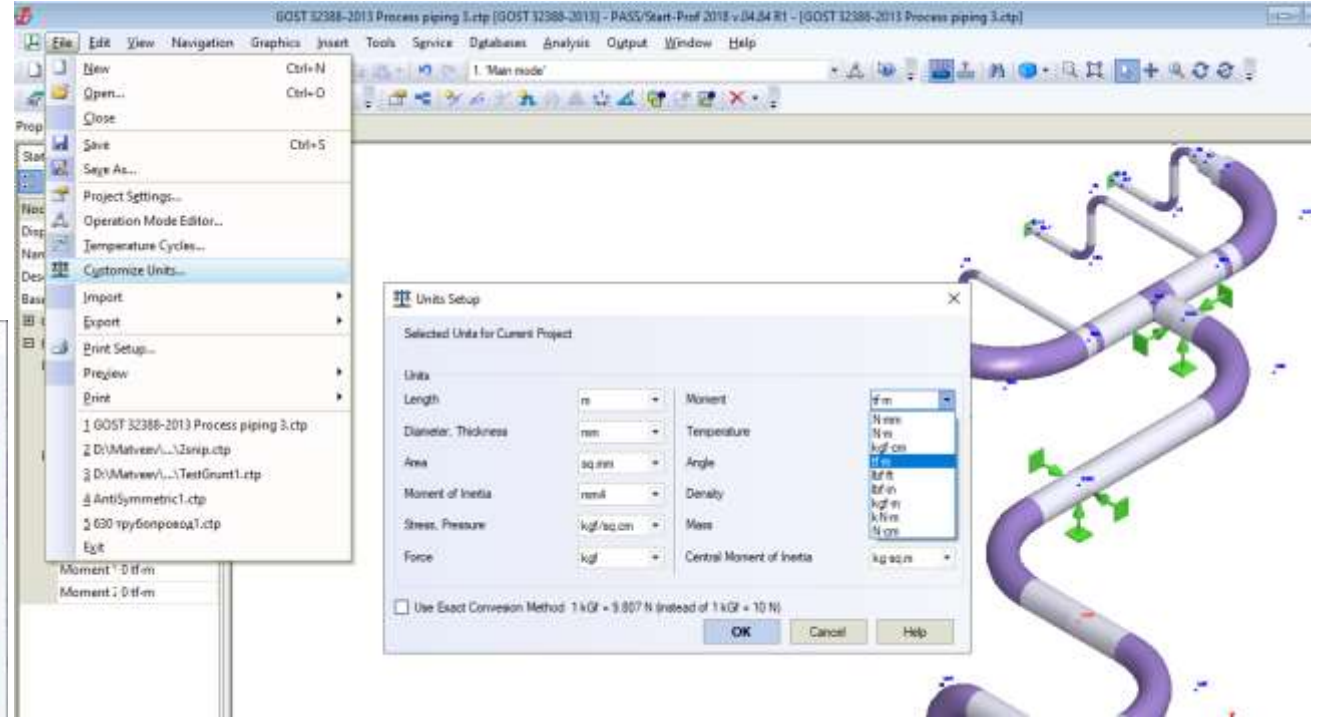
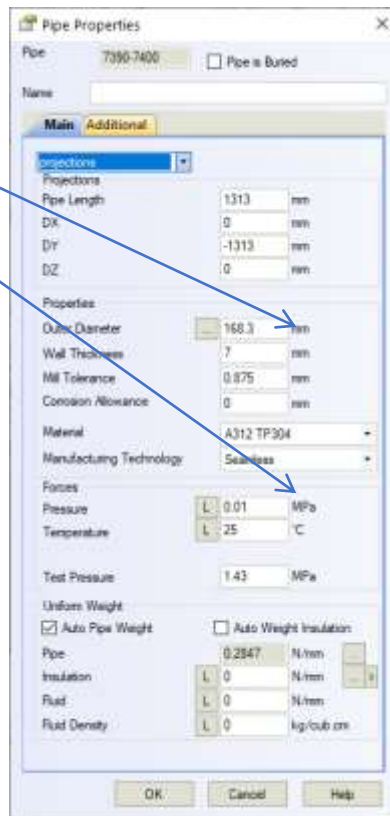
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# PASS/Start-Prof | Features

Change of the model units available at any moment of time on-the-fly, even after analysis is done.

The units are always displayed for each input field.

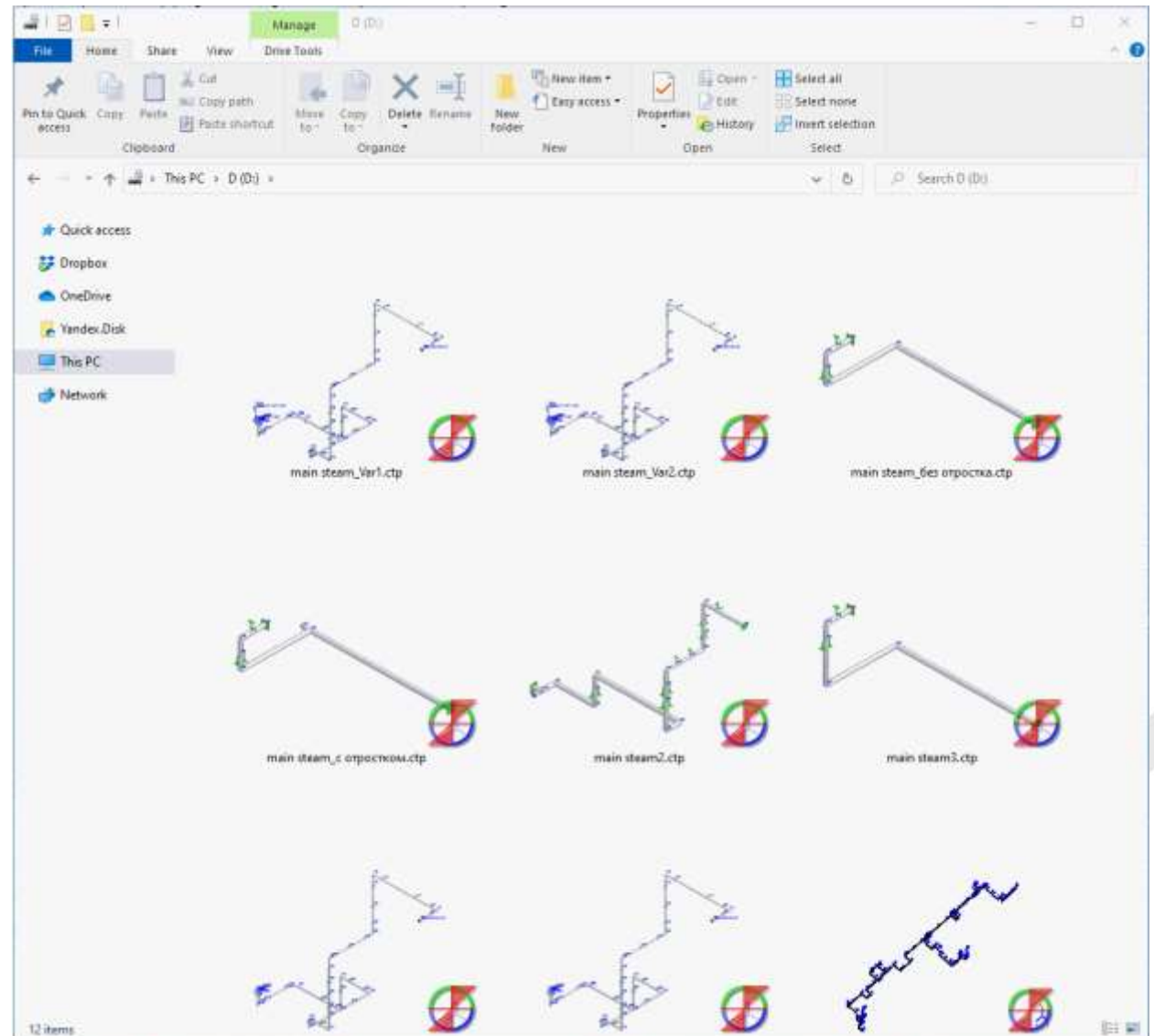


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# PASS/Start-Prof | Features

- Each piping system project is stored in just one file
- Thumbnails for windows explorer. You can preview all piping models right in the explorer before opening the file
- Fast opening even big models
- High speed of stress analysis and working with a really big models



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# PASS/Start-Prof | Reliability

Full Verification and Validation manual. Added a lot of verification examples, compared to manual calculations and other software.

The collage features several key elements:

- 3D Pipe Models:** Multiple 3D renderings of pipe systems, comparing 'START-PROF model' (e.g., 1848, 320571, NRG1, NRG4-1) with 'CAESAR II model' (e.g., 1848, 320571). The models show complex piping configurations with supports and stress indicators.
- Technical Drawing:** A detailed 2D drawing titled '1.6 ASME B31.3 Appendix S (S302) ASME B31.3-2018 Appendix S (S302) Model Figure S302.1 Liftoff Model'. It shows a lift-off configuration with dimensions in meters and feet (e.g., 12.2 m / 40 ft, 3.05 m / 10 ft, 9.15 m / 30 ft, 6.1 m / 20 ft) and numbered nodes (10-15, 20-30, 130-140, 110-115).
- Book Cover:** The cover of the 'PASS START-PROF Pipe Stress Analysis Software VERIFICATION AND VALIDATION MANUAL Version 4.84 July 2020'. The cover features the PASS logo and the text 'Pipe Stress Analysis Software'.
- Engineering Diagrams:** Various 2D diagrams showing pipe stress analysis results, including stress distribution plots and coordinate systems (X, Y, Z).



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# PASS/Start-Prof | Reliability

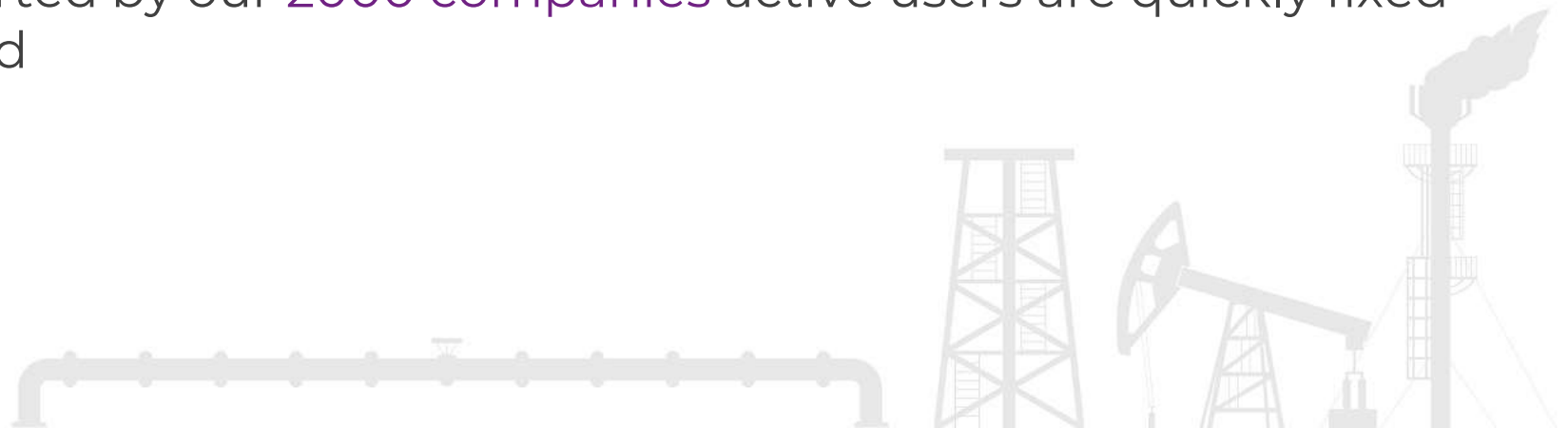
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Each new PASS/START-PROF release is:

- Automatically verified on more than **300 examples** with previous versions (quality assurance system)
- Checked manually with group of pipe stress experts (testers)
- Each release pass through 1-3 pipe stress trainings with 10-20 students before official release
- After release, all bugs reported by our **2000 companies** active users are quickly fixed and new release is provided



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# PASS/Start-Prof | Licensing

## Configurations/Pricing Options

<p><b>PASS/Start-Prof Complete Advanced</b></p> <p>Simulation and sizing for any piping network considering all applicable national codes.</p> <p><b>PASS/Start-Prof Complete Standard</b></p> <p>configuration includes only worldwide popular standarts.</p>	<p><b>PASS/Start-Prof Process Advanced</b></p> <p>Simulation and sizing for piping networks based on applicable national codes for process plants as well as for gas and oil transportation systems.</p> <p><b>PASS/Start-Prof Process Standard</b></p> <p>configuration includes only worldwide popular standarts.</p>	<p><b>PASS/Start-Prof Power Advanced</b></p> <p>Simulation and sizing for any piping networks based on applicable national codes for power generation piping as well as for central heating networks.</p> <p><b>PASS/Start-Prof Power Standard</b></p> <p>configuration includes only worldwide popular standarts.</p>	<p><b>PASS/START-PROF HDPE+FRP</b></p> <p>Piping stress analysis of high density polyethylene and/or fiberglass reinforced plastic piping systems.</p>
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- Permanent License at Affordable Price (+1 year maintenance for free!)
- Maintenance Renew 1 Year: 25%
- Annual License: 40%
- Semi-Annual License: 25%

## Configurations Comparison

Code	Complete Advanced	Process Advanced	Power Advanced	Complete Standard (40% discount)	Process Standard (40% discount)	Power Standard (40% discount)	HDPE+FRP (40% discount)
ISO 14692	✓	✓	✓				✓
HDPE Piping	✓	✓	✓				✓
ASME B31.1	✓		✓	✓		✓	
ASME B31.3	✓	✓		✓	✓		
ASME B31.4	✓	✓		✓	✓		
ASME B31.5	✓	✓	✓	✓	✓	✓	
ASME B31.8	✓	✓		✓	✓		
ASME B31.9	✓	✓	✓	✓	✓	✓	
EN 13480	✓	✓	✓	✓	✓	✓	
GB 50316	✓	✓	✓	✓	✓		
GB/T 20801	✓	✓		✓	✓		
GB 50251	✓	✓		✓	✓		
GB 50253	✓	✓		✓	✓		
DL/T 5366	✓		✓	✓		✓	
CJJ/T 81	✓		✓				
RD 10-249-98	✓		✓				
GOST R 55596	✓		✓				
GOST 32388	✓	✓					
SNIP 2.05.06-85	✓	✓					
SP 36.13330	✓	✓					



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# PASS/Start-Prof | Resources

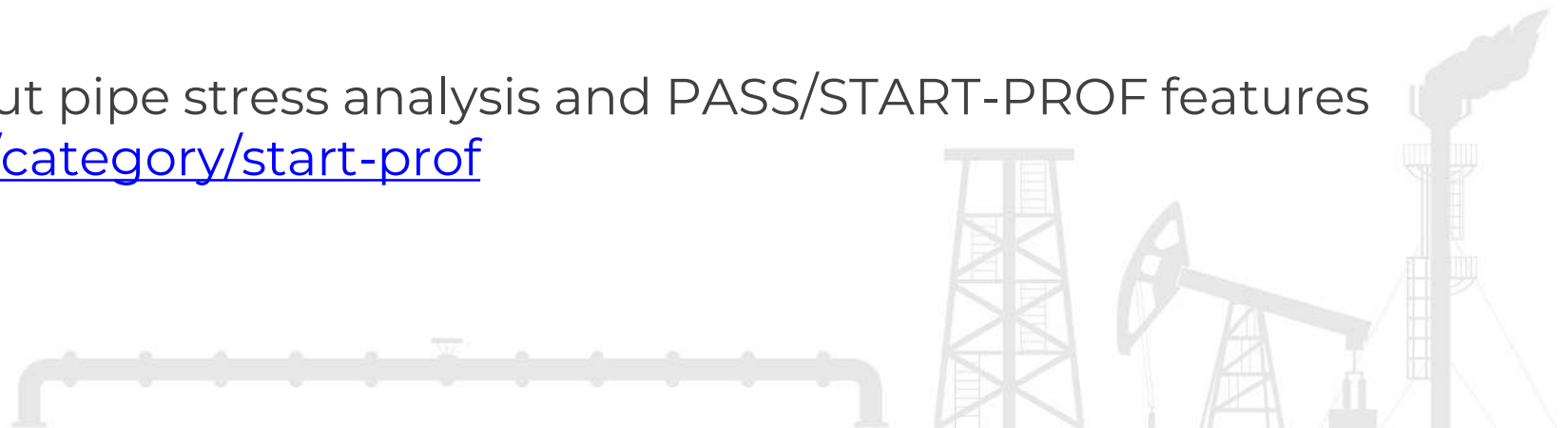
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- LinkedIn: [www.linkedin.com/company/passuite/](http://www.linkedin.com/company/passuite/)
- Facebook: [www.facebook.com/PASSuite](http://www.facebook.com/PASSuite)
- Twitter: [twitter.com/passuitecom](http://twitter.com/passuitecom)
- More than 50 articles about pipe stress analysis and PASS/START-PROF features  
<https://whatispiping.com/category/start-prof>



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# PASS/Start-Prof | Resources

- Online Help: [https://www.passuite.com/kbase/doc/start//WebHelp\\_en/index.htm](https://www.passuite.com/kbase/doc/start//WebHelp_en/index.htm)

**PASS** Start-Prof 4.84R1 User's Guide

The screenshot shows the PASS Start-Prof User's Guide web page. The left sidebar contains a navigation menu with categories like Temperature Cycles, Valve, Marker, Pipe Elements, Bends, Tees and Stub-ins, Reducers, Expansion Joints, Restraints, Equipment, Loads, Flaw, and Analysis Results. The main content area features the PASS START-PROF logo and the title "Pump API 610 / ISO 13709". Below the title is a 3D model of a blue pump. The text describes the pump element and provides a list of options for using it. A "Node Object Properties" dialog box is overlaid on the 3D model, showing settings for the pump element.

**PASS START-PROF**

## Pump API 610 / ISO 13709

Read about [START-PROF pipe stress analysis software](#)

**Related Topics**

This element allows to model the pumps and check the loads according to API 610 / ISO 13709 standards. One "Pump" object can be connected to one or two nodes. Allowable loads are checked for each individual nozzle and for whole pump. Analysis results can be found in [Loads on Nozzles and Equipment Table](#). See also [How to Reduce the Nozzle Loads in START-PROF](#)

There can be two options of using pump element:

1. Put Pump nozzles into the pipe end nodes. In this case, the pump nozzles are automatically modeled as an anchors. Pump temperature expansions are automatically modeled as anchor movements.

**Node Object Properties**

Pump API 610/ISO 13709

Name

Material of Pump: 20

Temperature of Pump: 150 °C

Manufacturer: Rowlede Multiplier: 1

Table Nozzle Loading Factor: 2

Shaft Axis: X

Pump Center Coordinate from Node: 142

Di: 517

Di: 2000 mm, Di: 2000 mm, Di: 0 mm

Reverse Restraints for Hanger Selection

Don't Remove

Rotation Mode

142 Side  Set Loads

Discharge Node

716 Side  Set Loads



# PASS/Start-Prof | Resources

Subscribe our YouTube channel, you will find a lot of PASS/START-PROF training videos

[www.youtube.com/passuite](http://www.youtube.com/passuite)



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A screenshot of the PASS YouTube channel page. The page header shows the channel name "PASS" with 716 subscribers and a "SUBSCRIBED" button. Below the header are navigation tabs for HOME, VIDEOS, PLAYLISTS, CHANNELS, DISCUSSION, and ABOUT. The main content area displays a grid of video thumbnails with titles and view counts. The videos cover various topics such as software overviews, import tutorials, and specific analysis cases.

Video Title	Views	Time Ago
PASS/EQUIP Overview Webinar: Comprehensive...	124 views	4 days ago
PASS/START-PROF Overview Webinar: Your software for...	334 views	2 months ago
PASS/Equip Nozzle-FEM Overview Webinar: Powerful...	135 views	2 months ago
How to Import piping model from CADWorx to START-...	193 views	2 months ago
How to Import piping model from CADWorx to START-...	119 views	2 months ago
PASS/HYDROSYSTEM Overview Webinar...	229 views	3 months ago
PASS/START-PROF was used for 2022 Winter Olympic...	162 views	4 months ago
Beijing Universal Amusement Park Buried Hot Water Pipin...	261 views	4 months ago
PASS/START-PROF Overview Webinar: Your software for...	196 views	5 months ago
New START-PROF option: Import from Autodesk Revit	370 views	6 months ago
18 How to calculate the 'slurry' flow in Hydrosystem	111 views	9 months ago
17 How to calculate the gas liquid liquid flow in...	134 views	9 months ago
How to import PCF file to START PROF	365 views	1 year ago
How to run PASS/START PROF Trial	1.3K views	1 year ago
Pipe Stress Analysis From Water Hammer Loads	2.2K views	1 year ago
Creating a Simple Piping Model Tutorial in START-...	TK views	1 year ago
CAESAR II Convergence Issue (2019 training) Piping...	5K views	1 year ago
Big Piping Model Analysis Tutorial with PASS/START-...	1.4K views	1 year ago
GRP / GRE / FRP Piping Stress Analysis Tutorial usi...	8:27	
HDPE Piping Stress Analysis Tutorial With PASS/START-...	4:07	
HDPE Piping Stress Analysis With PASS/START-PROF...	13:06	
Two-way integration between PASS/Start-Prof Pipe Stress...	3:25	
16 Interface between Hydrosystem and START-...	2:30	
Buried Piping/Pipelines Stress Analysis with...	26:21	

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# Thank YOU!