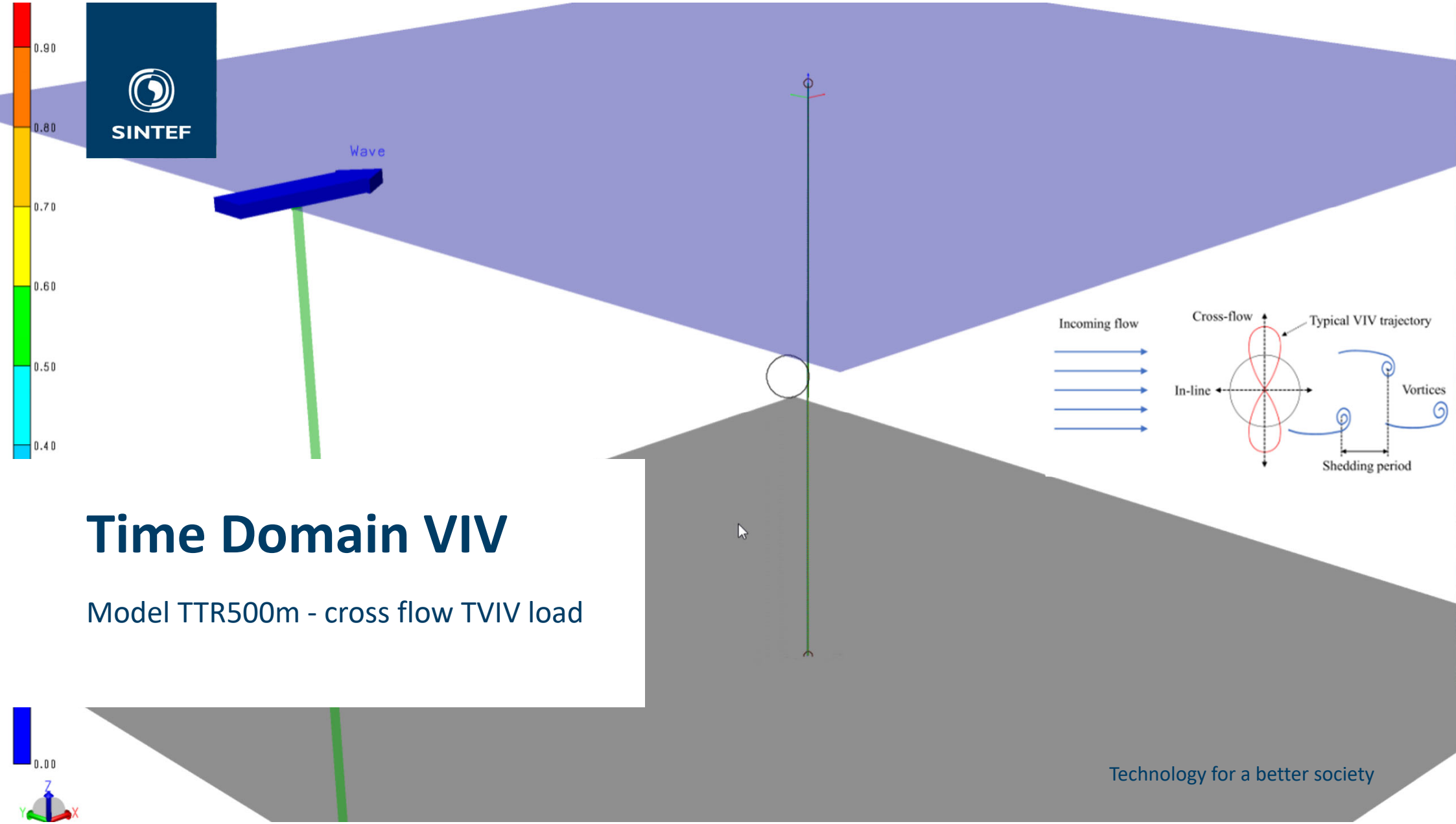
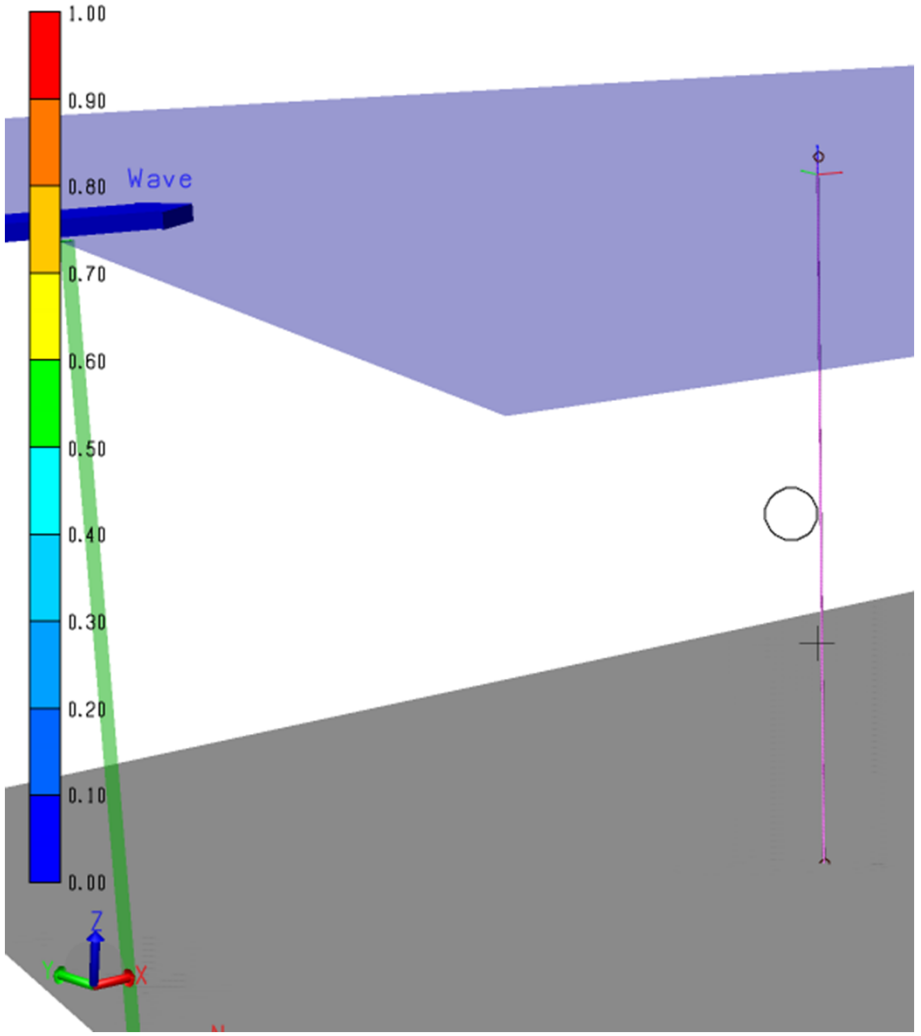


Time Domain VIV

Model TTR500m - cross flow TVIV load

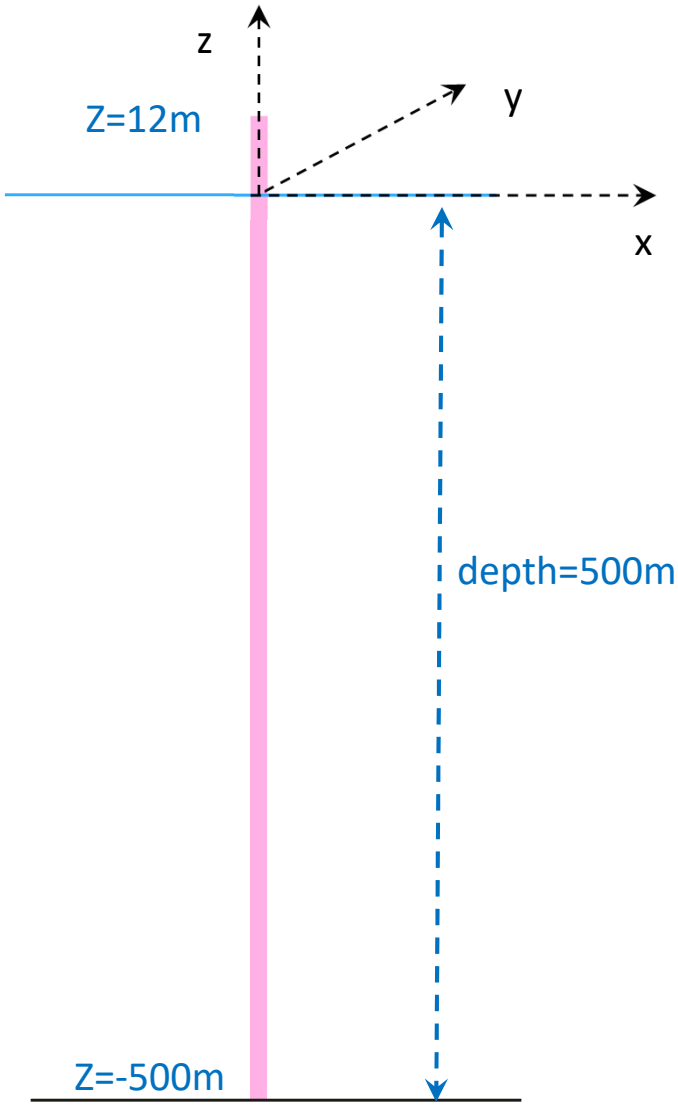
Example: TTR 500m

- Simple, vertical top tensioned riser
- Shared to the JIP members



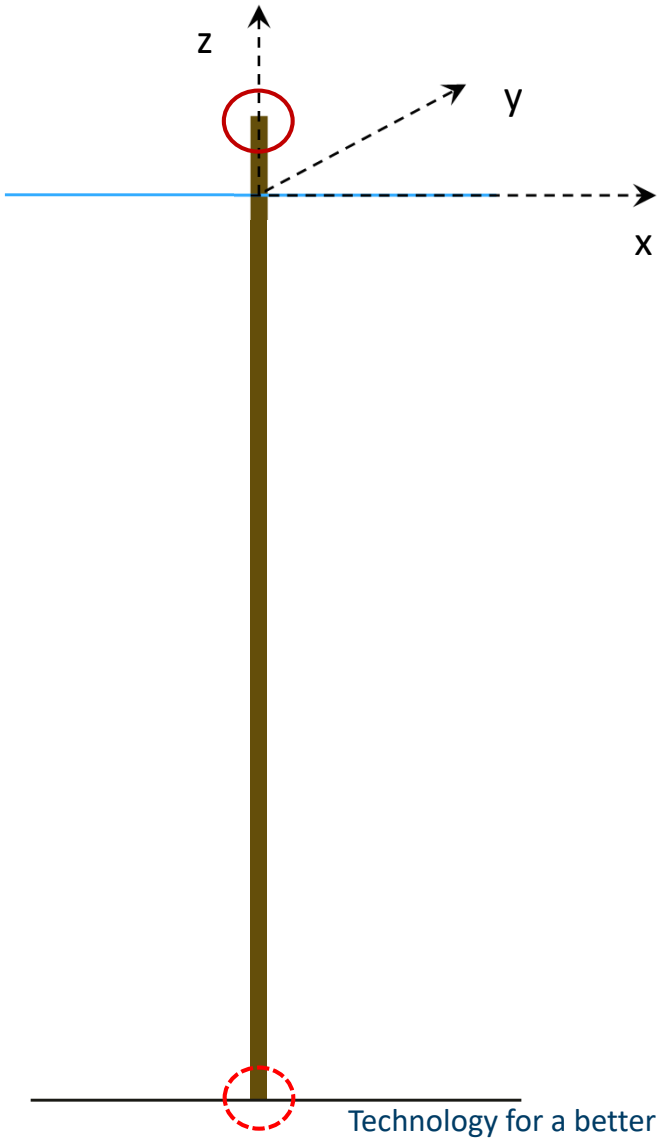
TTR 500m

Constants	value	SI-Unit	Comments
Water depth	500	m	
Upper end	12	m	above surface
Lower end	-500	m	below surface, at seabed
Total length	512	m	
Density, pipe	7850	kg/m3	
Mod of elasticity	206000	MPa	
Density int. fluid	1400	kg/m3	
Densit sea water	1025	kg/m3	
Gravity	9.81	m/s2	
Cd	0.8		
Cm	1		
Tension at low. end	400	kN	
Strouhal number	0.2		



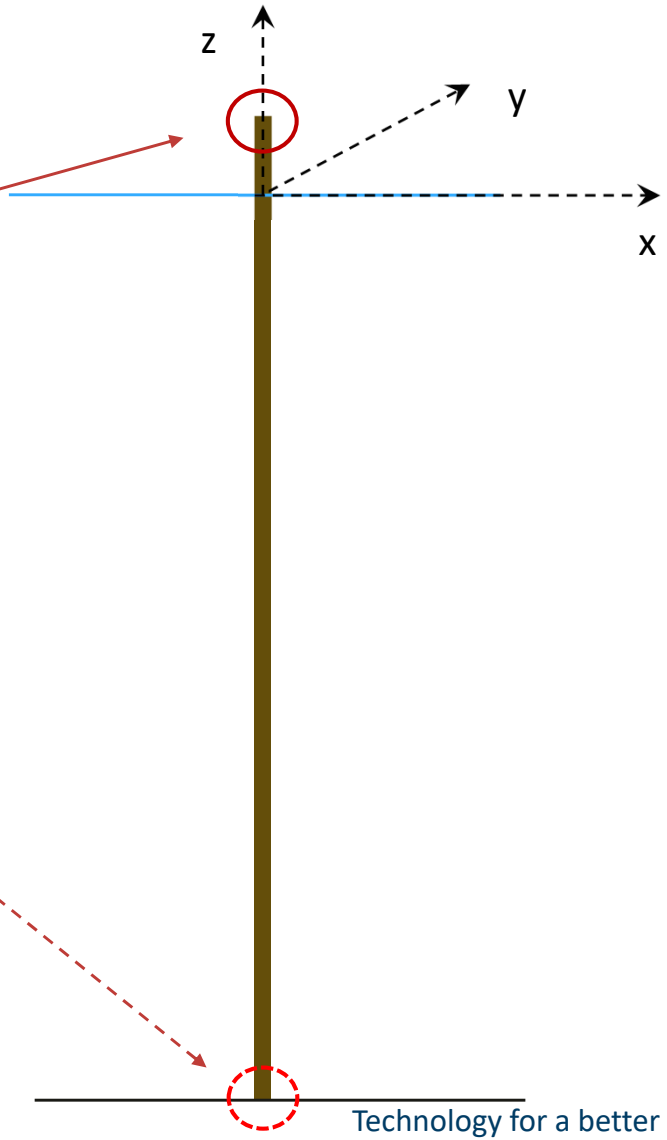
Structural properties – cross section

Bare riser data	value	SI-Unit
External diam	0.6	m
Wall thichness	0.02	m
Internal diam	0.56	m
Internal area	0.2463	m2
External area	0.2827	m2
Cross sect area	0.0364	m2
Mom of inert	0.00153	m4
Mass of pipe	286.07343	t/m
Mass of content	344.82121	t/m
Total mass, air	630.89464	t/m
Total mass in water	920.70656	t/m
Wet effective weight	3346.02143	kN/m
Dry effective weight	6189.07639	kN/m
Tot effect. weight	1747279.63	kN
Needed top tension	1747679.63	kN
EI	316051	kN/m2
EA	7507150	kN/m
Average tension	874039.8	kN



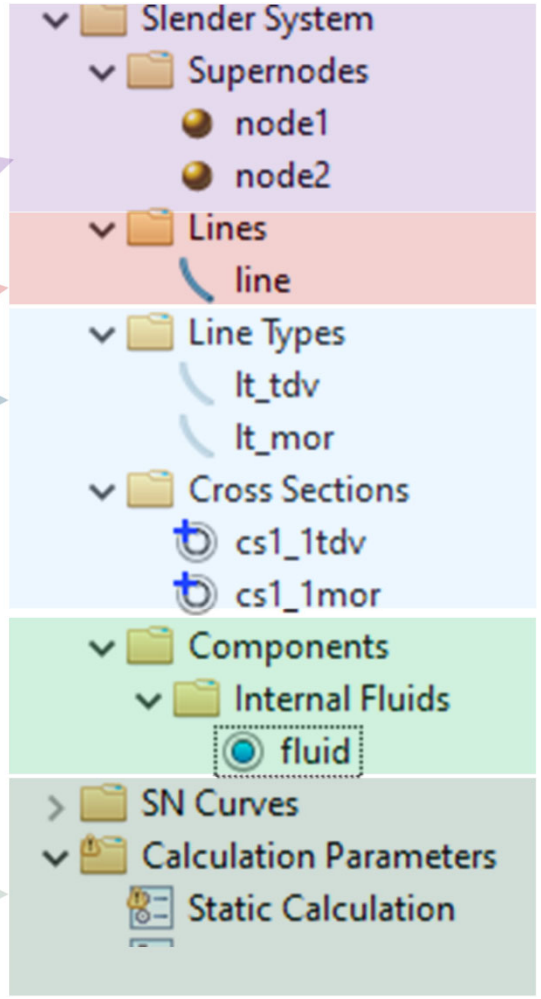
Boundary conditions

Constants	value	SI-Unit
	upper end	*lower end*
displ, x	fixed	fixed
displ, y	fixed	fixed
displ, z	free	fixed
rot, x	free	free
rot, y	free	free
rot, z	fixed	free



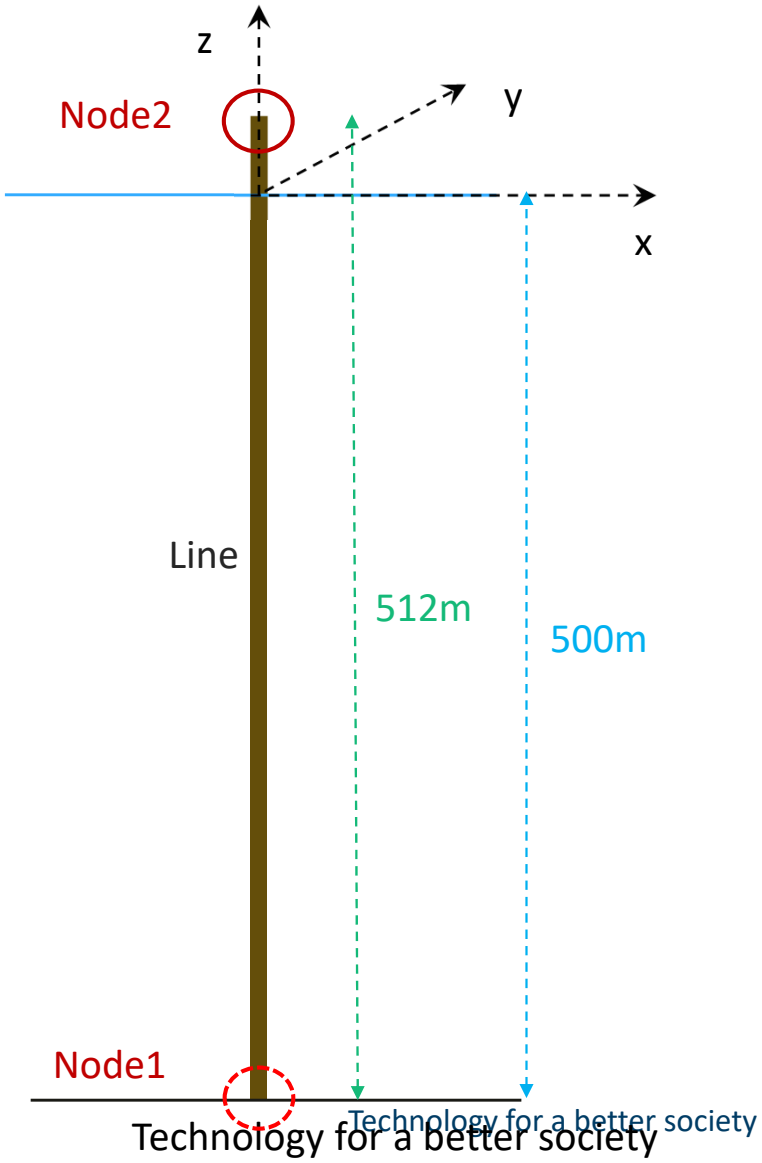
Slender system

- Two super nodes with boundary conditions
- One line between the two nodes
- The line type consist of
  - Four segments (i.e. typical a length of the line with a specific cross section type)
  - Cross section with hydrodynamic load
- The riser is filled with fluid (i.e. a component type)
- The riser is top tensioned
  - The force is specified in the static calculation
  - Specified in the static calculation parameters



Define the slender system

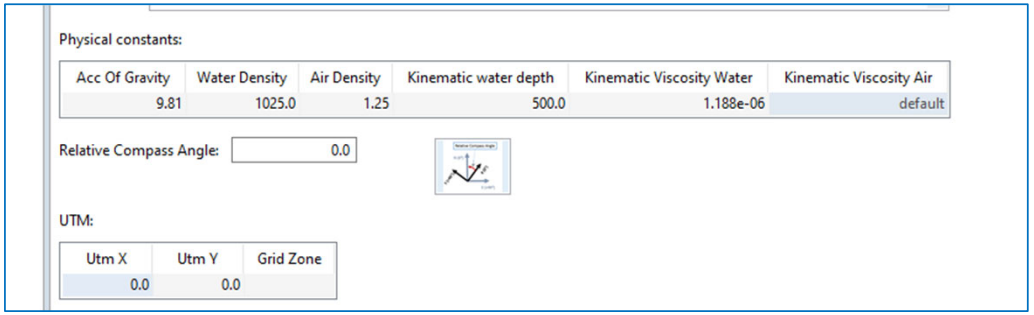
- One line –> four segments –> one cross section
  - Line from node1 to node2
  - Line of line type with different hydrodynamic loads
    - Lt_tdv
      - Cross section with CF and IL calculated separately
    - Lt_mor
      - Morison only
      - Added for comparison

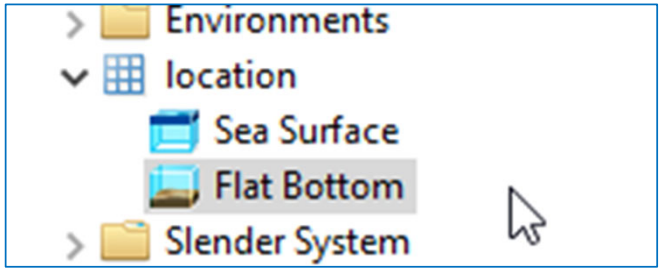


Technology for a better society

Location

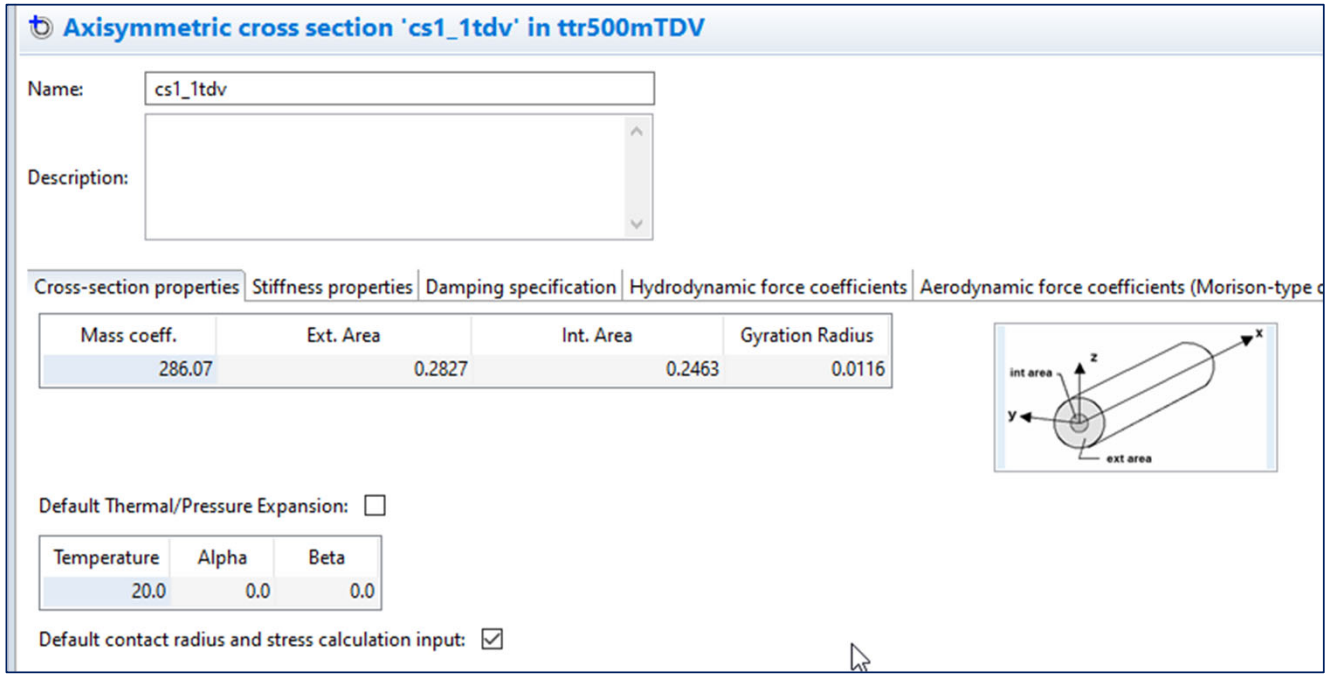
- Physical constants
  - Gravity, water depth etc, density etc
- Sea surface
- Sea floor
  - Here: flat bottom





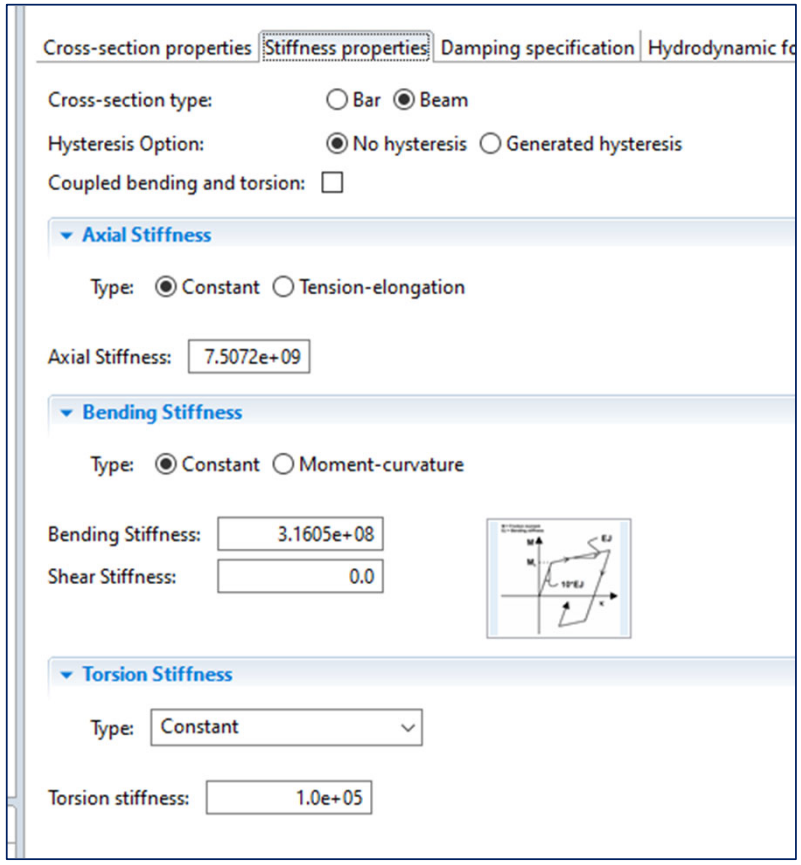
Define an axisymmetric cross section

- Cross- section properties



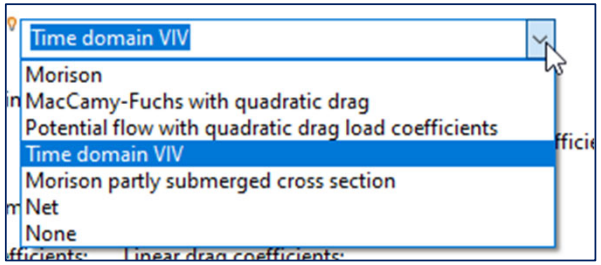
Stiffness properties

- Beam elements
- Axial stiffness
- Bending stiffness
- Torsion stiffness

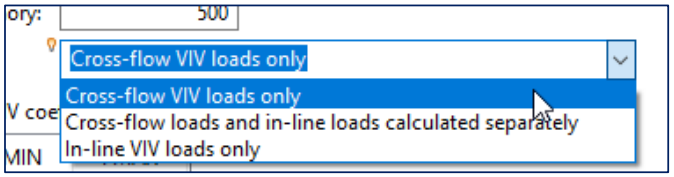


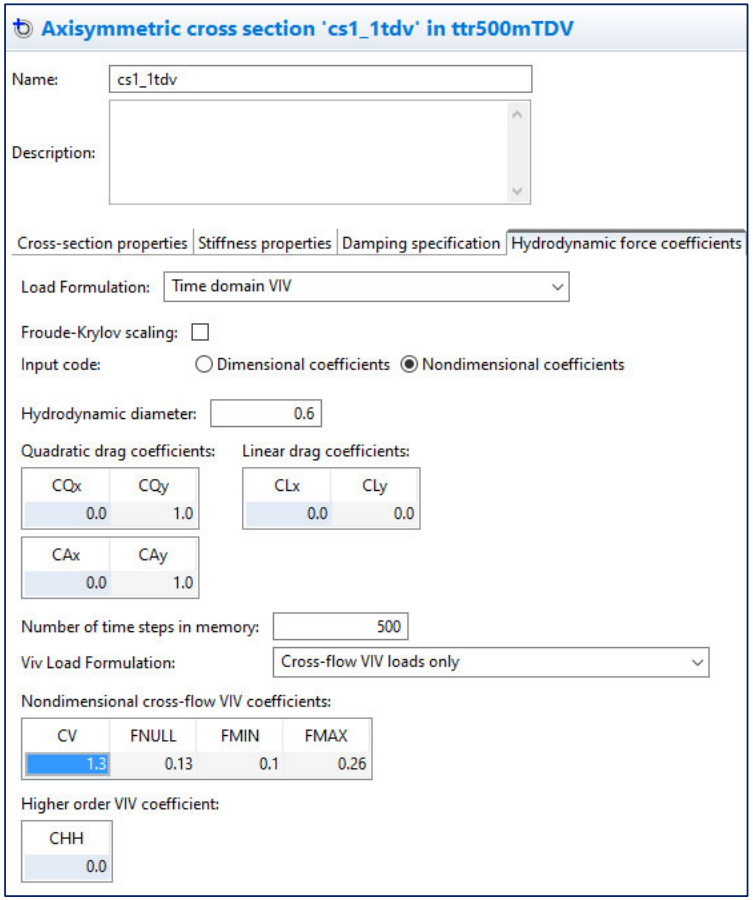
Hydrodynamic force coefficients

- Choose the load formulation (drop down list)



- Time domain VIV





TDV coefficients

- See User Manual (SIMA 4.6.3)

Table 1. Suggested VIV empirical parameters used for CHTVIV=CF, i.e. Cross flow only. CQY and CAY are nondimensional drag force and added mass coefficients in normal direction.

Flow conditions	Structure type		Parameters					
			CV	CQY	CAY	FNULL	FMIN	FMAX
Constant current	Bare riser section		1.3	1.0	1.0	0.13	0.10	0.26
	Buoyancy section (L_b/L_r=1/2)	Bare riser	1.2	0.9	1.0	0.18	0.10	0.22
		Buoyancy element	0.08	0.3	1.0	0.10	0.05	0.15
	Buoyancy section (L_b/L_r=1/1)	Bare riser	0.8	1.2	1.0	0.18	0.10	0.26
		Buoyancy element	0.5	0.6	1.0	0.10	0.05	0.15
Vessel motion induced VIV	Bare riser & buoyancy section		0.8	1.2	1.0	0.216	0.10	0.26

Other

- Damping
- Aerodynamic force coefficients
- Capacity

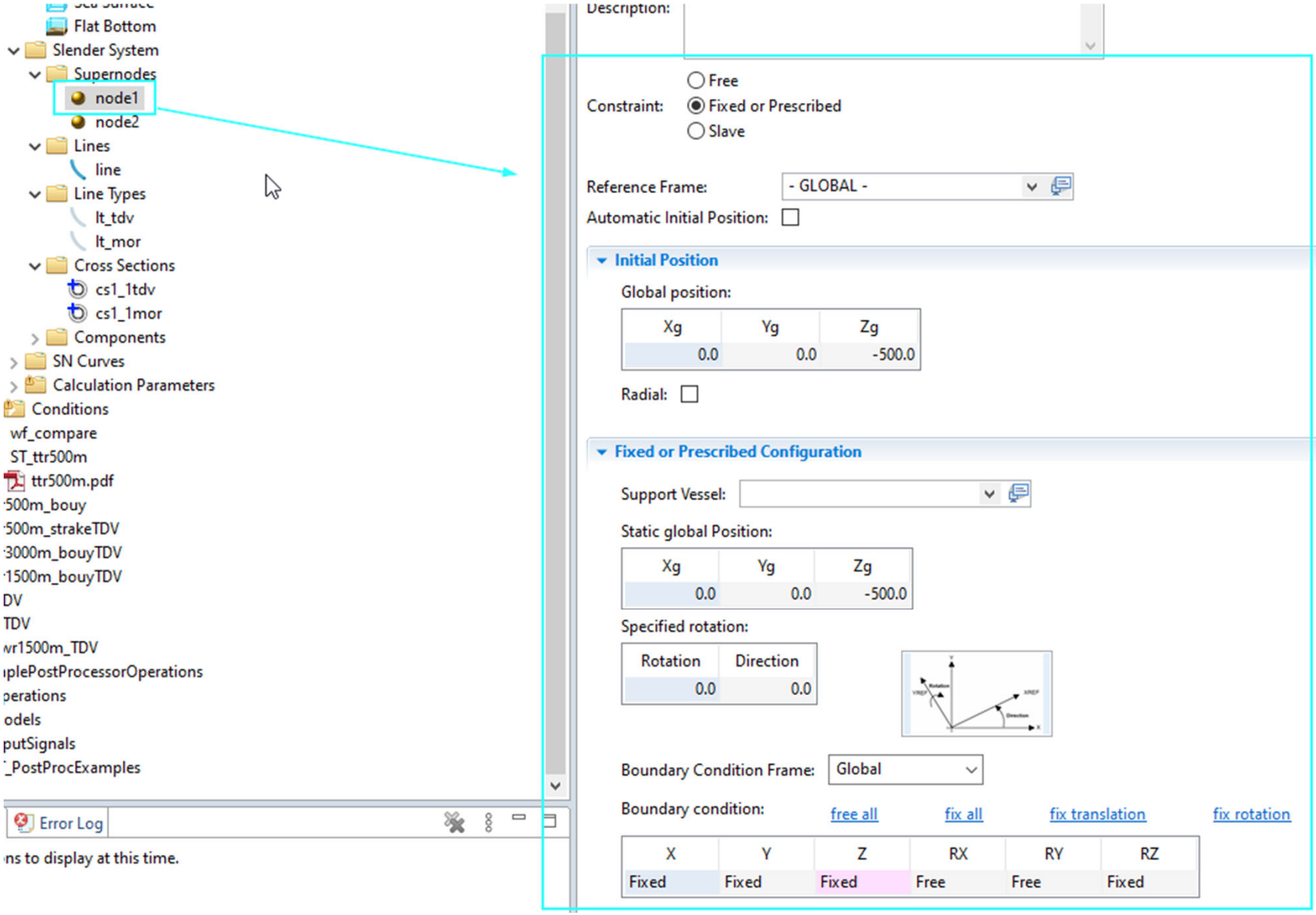
Super nodes

- Node1 – sea floor
- Node 2 – at the top of the ttr

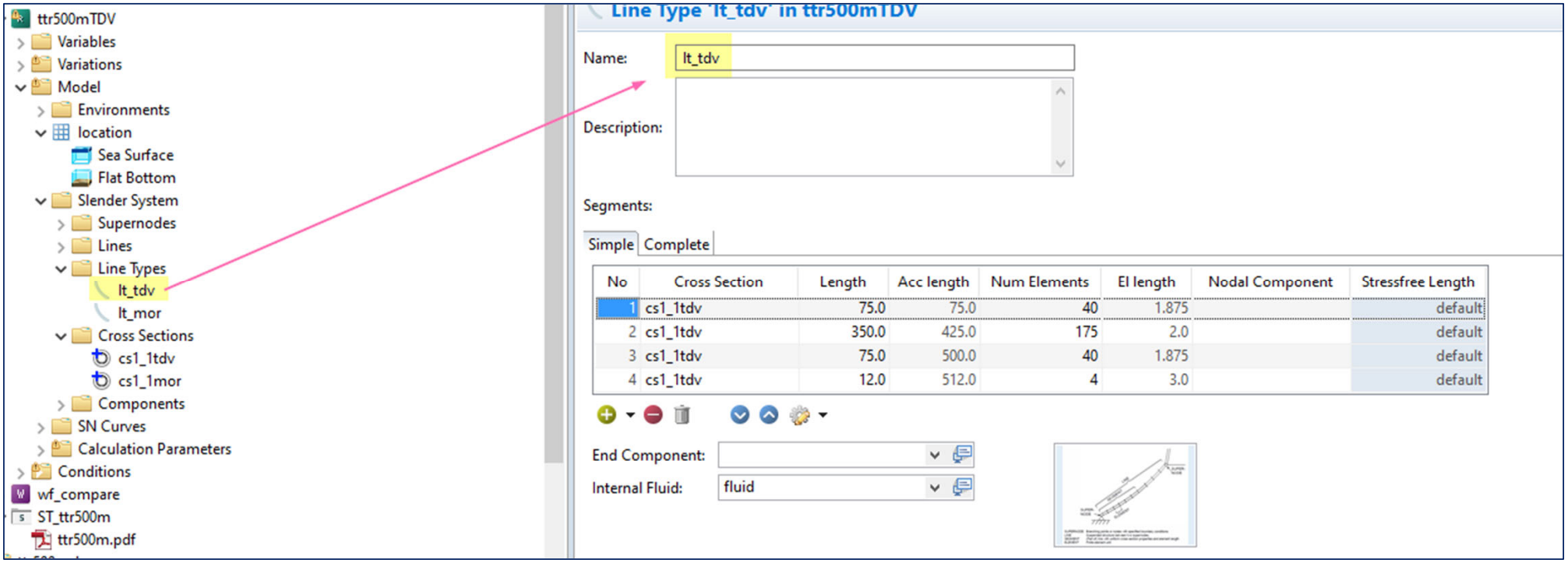
The 'Initial' tab contains initial position of nodes while 'Static' tab shows postion of nodes after prescribed (static) displacements have been applied.

Initial | Static

Name	Constraint	X G Initial	Y G Initial	Z G Initial	Automatic Initial Position	Reference Line	Reference Frame
node1	Fixed or Prescribed	0.0	0.0	-500.0	☐		- GLOBAL -
node2	Fixed or Prescribed	0.0	0.0	12.0	☐		- GLOBAL -

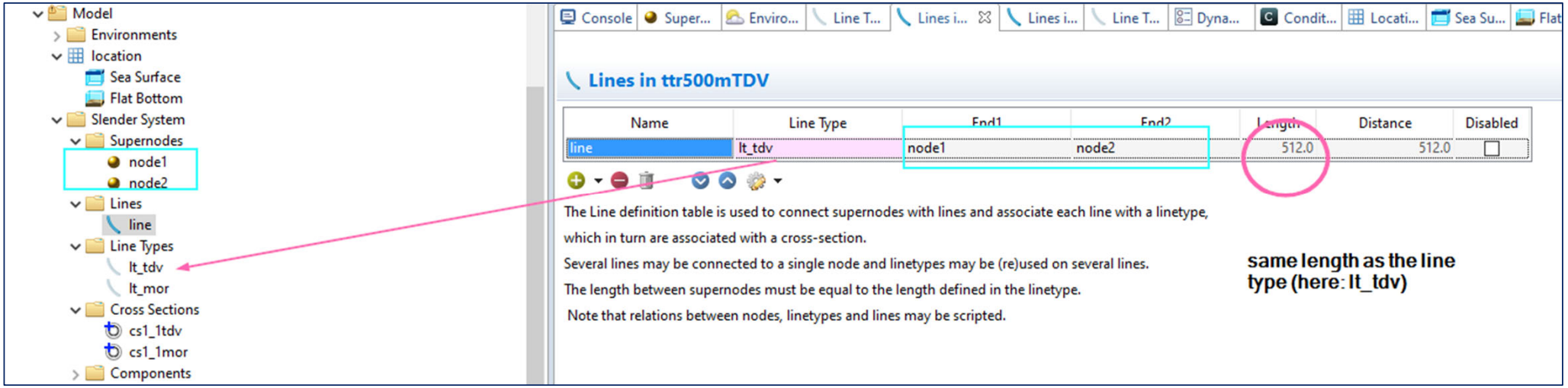

Flat Bottom
Slender System
Supernodes
node1
node2
Lines
line
Line Types
lt_tdv
lt_mor
Cross Sections
cs1_1tdv
cs1_1mor
Components
SN Curves
Calculation Parameters
Conditions
wf_compare
ST_ttr500m
ttr500m.pdf
500m_bouy
500m_strakeTDV
3000m_bouyTDV
1500m_bouyTDV
DV
TDV
vr1500m_TDV
plePostProcessorOperations
perations
odels
putSignals
_PostProcExamples
Error Log
ns to display at this time.
Description:
Free
Constraint:
Fixed or Prescribed
Slave
Reference Frame:
- GLOBAL -
Automatic Initial Position:
Initial Position
Global position:
Xg
Yg
Zg
0.0
0.0
-500.0
Radial:
Fixed or Prescribed Configuration
Support Vessel:
Static global Position:
Xg
Yg
Zg
0.0
0.0
-500.0
Specified rotation:
Rotation
Direction
0.0
0.0
Boundary Condition Frame:
Global
Boundary condition:
free all
fix all
fix translation
fix rotation
X
Y
Z
RX
RY
RZ
Fixed
Fixed
Fixed
Free
Free
Fixed

Line type

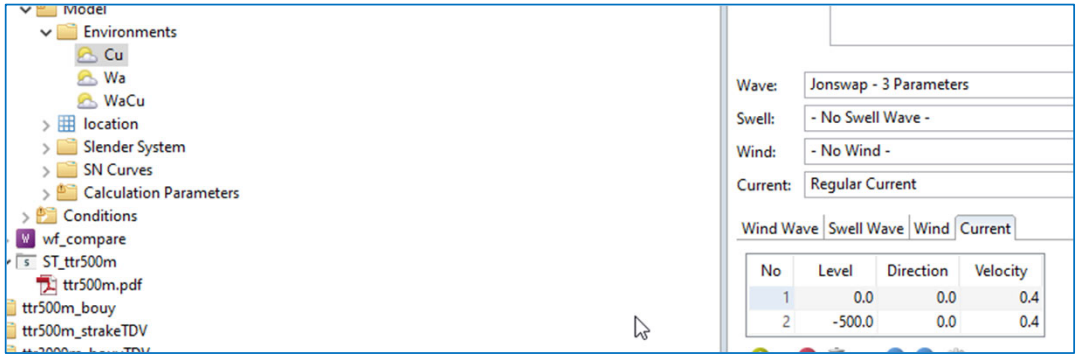

ttr500mTDV
Variables
Variations
Model
Environments
location
Sea Surface
Flat Bottom
Slender System
Supernodes
Lines
Line Types
lt_tdv
lt_mor
Cross Sections
cs1_1tdv
cs1_1mor
Components
SN Curves
Calculation Parameters
Conditions
wf_compare
ST_ttr500m
ttr500m.pdf
Line Type 'lt_tdv' in ttr500mTDV
Name:
lt_tdv
Description:
Segments:
Simple
Complete
No
Cross Section
Length
Acc length
Num Elements
El length
Nodal Component
Stressfree Length
1 cs1_1tdv 75.0 75.0 40 1.875 default
2 cs1_1tdv 350.0 425.0 175 2.0 default
3 cs1_1tdv 75.0 500.0 40 1.875 default
4 cs1_1tdv 12.0 512.0 4 3.0 default
End Component:
Internal Fluid:
fluid

Line between two super nodes of a line type

- Link the line to the super nodes and line type you want to use



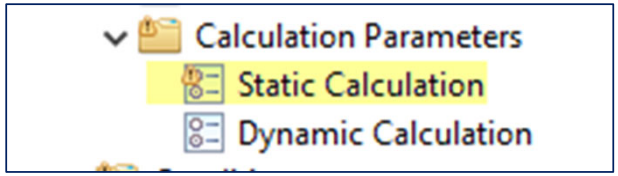
Environments



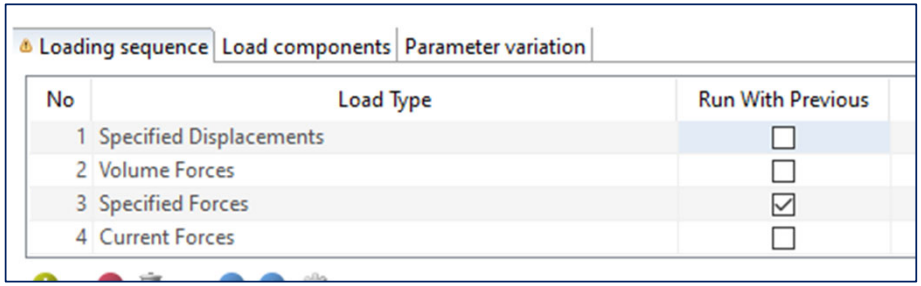
- In the example, there are three environments
  - Current only (Cu)
  - Waves only (Wa)
  - Waves and current (WaCu)

- Referred to by *conditions*

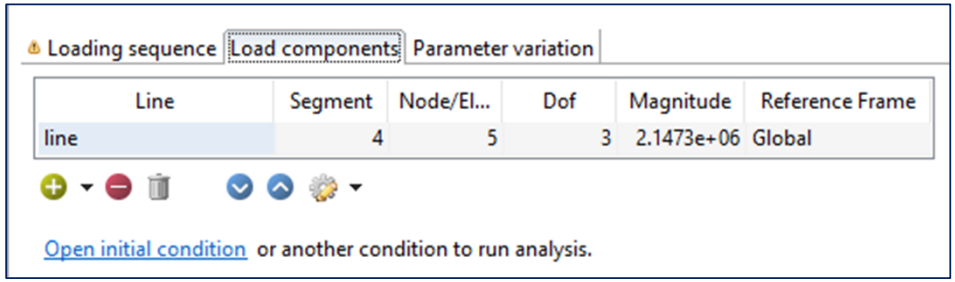
Static parameters



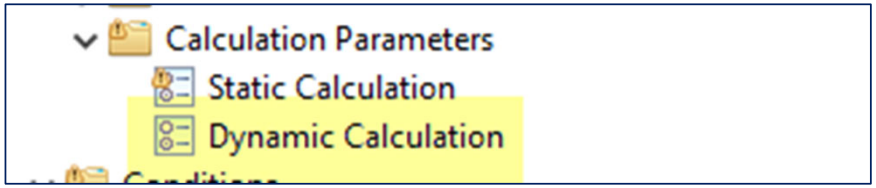
- Specify the order of the load types to be applied in the static run
  - 4 load groups in this case
  - Specified forces
  - Volume forces
  - Specified forces *(see bullet point 2)*
  - Current forces



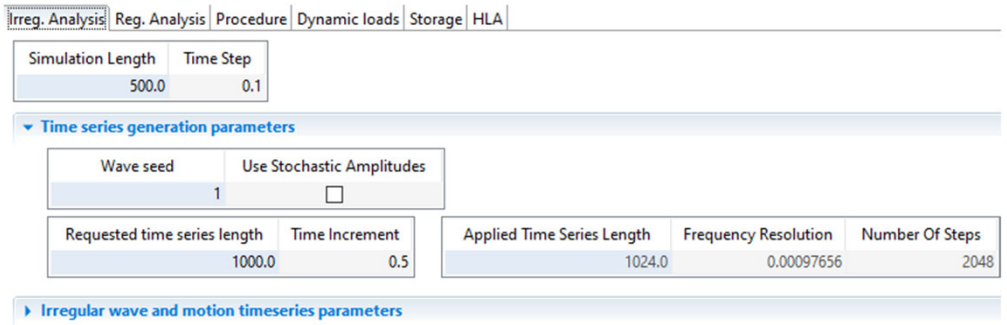
- Specify the tension force in the top node
  - T=21473 KN in Global z-direction (dof_3) in super node ***node_2*** (=segment 4 & node 5)
  - *NOTE: The force is added in static analysis using the load group **Specified forces***



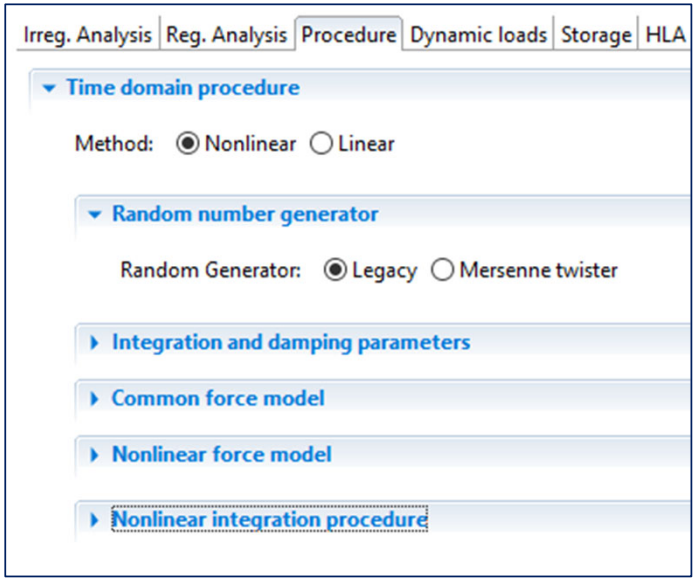
Dynamic parameters



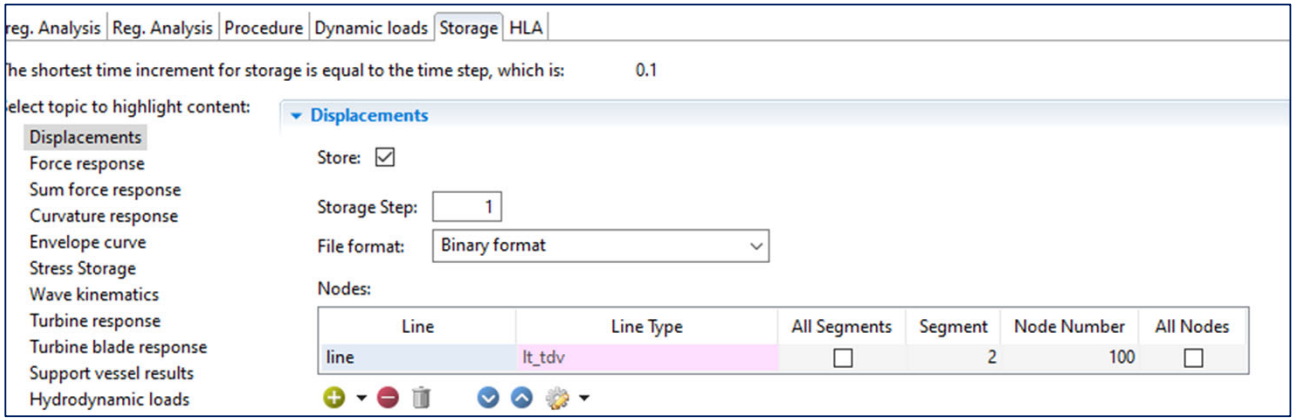
- Set up the dynamic analysis
  - Simulation length and time steps
- Time series generation parameter
  - Related to pre-generated kinematics
  - NOTE:
    - Requested time series length > Simulation length



- Dynamic procedure
  - Random number, integration and damping parameters
  - Force model
  - Nonlinear integration procedure
    - Convergence criteria

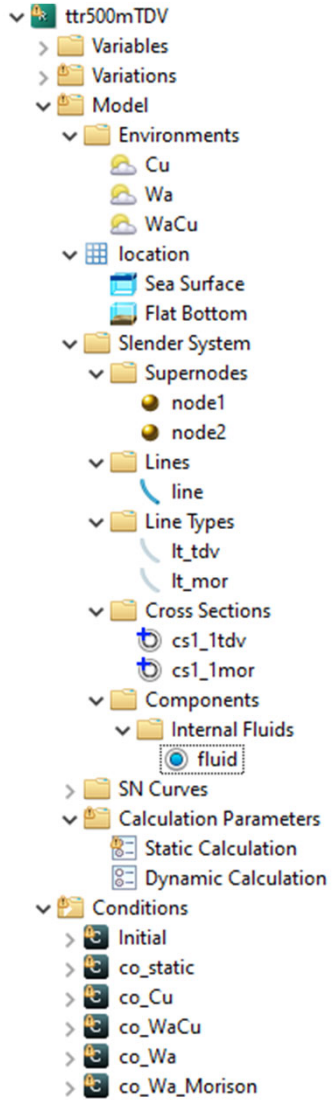


- Dynamic loads
- Storage of data
  - Displacement



Full model

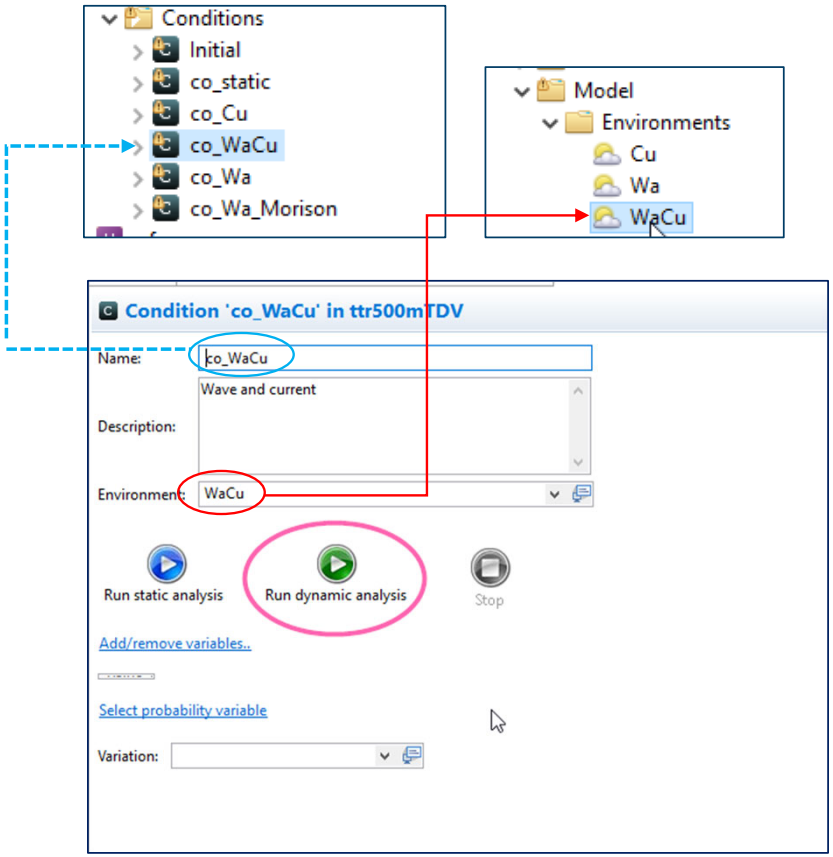
- Environment
- Location
- Slender system – where the TTR is defined
  - Super nodes
  - Lines and Line types
  - Cross sections
  - Components
    - Internal fluid
- SN curves
- Calculation parameters
  - Static & dynamic settings
- Conditions of the model
  - Initial is the base case
  - Initial always use the first listed environment



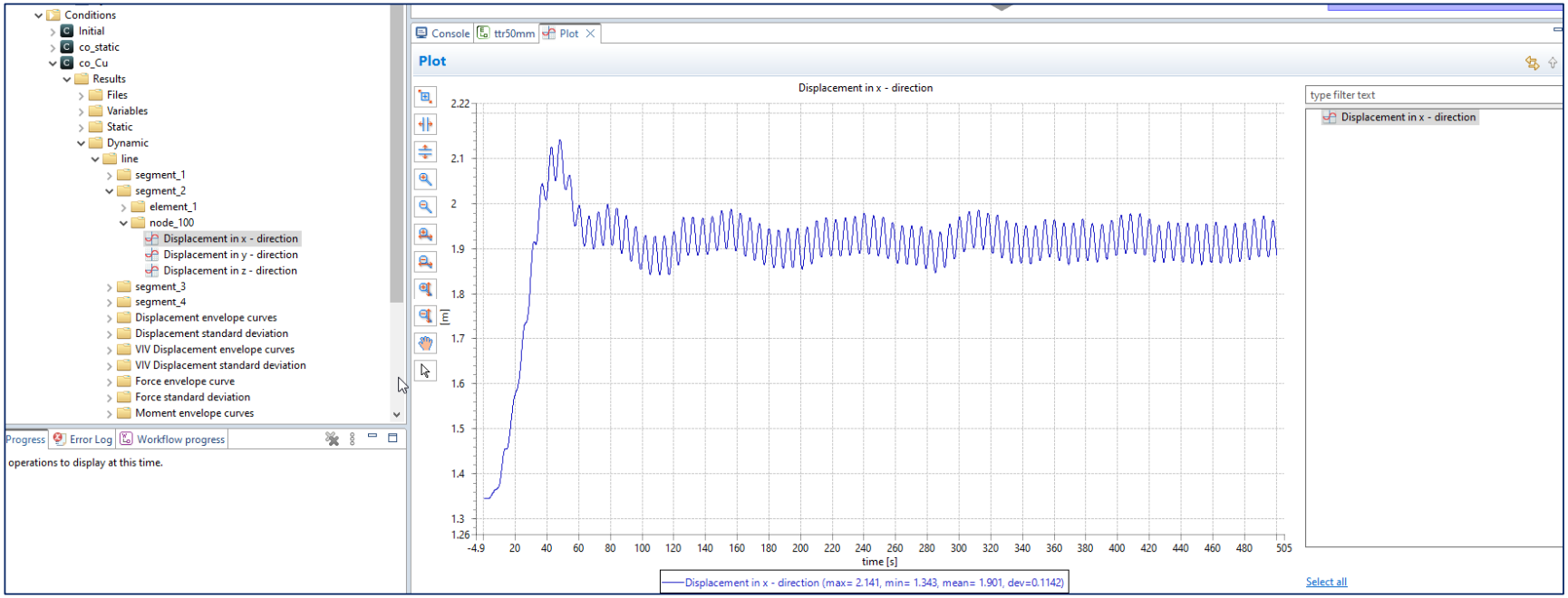
Run a condition

- Choose condition
- Run dynamic

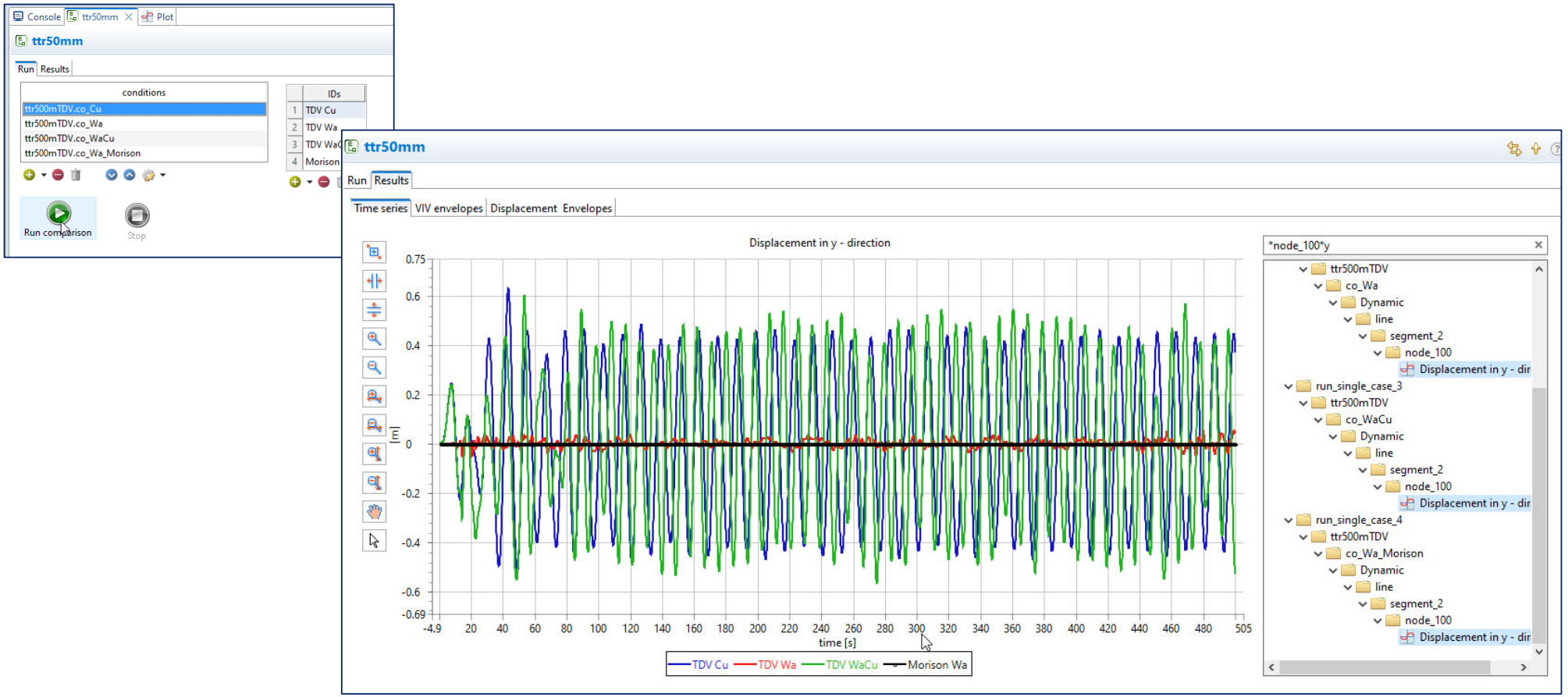
- Example:
  - Condition: Co_WaCu
  - Environment *WaCu* (Wave and Current)
    - Hs=5m, Tp=15s
    - Uniform current 0.4m/s
  - Line type with TDV loads on cross sections (default)



Look at results



Compare environments & TDV v Morison



SINTEF

Technology for a better society