Declaration of Conformity

REPORT NUMBER:
311113-1

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Init.: ALSN/UHI
Order no.: 311113-1
Appendices: 1

Assignor: Uponor Infra AB
Industrivägen 11
SE-51332

Subject: Review and declaration of conformity of FEM-calculations for Holding Tank 5m^3.

Documentation: The assignor has sent calculations for review on 2025-03-07. Document name: "Holding Tank 5m3".

Method: EN 12566-1:2016: Small wastewater treatment systems for up to 50 PT –
PART 1: Prefabricated septic tanks.
EN 12566-3:2016: Small wastewater treatment systems for up to 50 PT –
PART 3: Packaged and/or site assembled domestic wastewater treatment plants.

Result: The calculation conforms to the calculation method described in the standard above.

Remarks: The calculation was reviewed between the 2025-03-18 and 2025-03-19 without comments from DTI.

Terms: This analysis was conducted accredited in accordance with international requirements (ISO/IEC 17025:2017) and in accordance with the General Terms and Conditions of Danish Technological Institute. The test results solely apply to the tested item. This analysis report/test report may be quoted in extract only if Danish Technological Institute has granted its written consent.

Place: 2025-03-25, Danish Technological Institute, Building and Construction, Aarhus

Signature: This document is only valid with a digital signature from Danish Technological Institute. The date of issue appears from the digital signature. Approved and signed by:

Performed by:	**Co-reader:**
Allan Nielsen	Ulrik Hindsberger
Specialist	Centre Project Manager

DIGITALLY SIGNED DOCUMENT
25 March 2025
DANISH TECHNOLOGICAL INSTITUTE

ilac-MRA
DANAK
Test Reg. No. 2
CPR NB 1235

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Construction Product Regulation:

In accordance with Regulation (EU) No. 305/2011 of the European Parliament and of the Council, the Construction Products Regulation (CPR), the test was conducted for the purpose of the assessment of the performance under AVCP System 3 as described in Regulation (EU) No. 568/2014 and in compliance with all applicable provisions of the CPR. The Danish Technological Institute is a notified body in accordance with CPR Article 48.

January 2021

Holding Tank 5m3

FEM ANALYSIS FOR LOAD BEARING CAPACITY

ZHANG, JOHN

Table of Contents

1. Introduction

According to EN 12566-1:2016 5.1.1, for buried installation, the load bearing capacity of the septic tank shall be established:

- *Either by calculation with the knowledge of basic data for material and loads.*
- *Or by test directly on the tank of the unit.*

For the project of Holding Tank 5m3, the load bearing capacity will be established by calculation with the FEM analysis software using Method 1 in EN12566-1:2016 5.1.2.1.

1.1. Job description

This FEM analysis performs the calculation of load bearing capacity based on the 3D model for roto-mould tooling and the knowledge of basic data for material and loads.

3D model is simplified to reduce the FEM calculation time.

Basic parameters of the raw material for FEM calculation are based on experience data within Uponor.

Constraints are based on installation instruction made by Uponor.

Loads are defined according to standard of EN 12566-1:2016 5.1.2.

FEM calculation is performed by the application of “Ansys 2021”. 3D model is prepared by the application of “Solidworks 2020”.

1.2. Analysis objectives

The target of this FEM analysis is to estimate the load bearing capacity of the Holding Tank 5m3, to check if the design can meet the requirements addressed in EN 12566-1:2016.

1.3. Analysis model

The original CAD model (Figure 1) is a solid filled model. This model has no internal features as it's designed for the tooling of roto-mould. The overall wall thickness is 11mm. Minus variation of the wall thickness is not considered in this calculation.

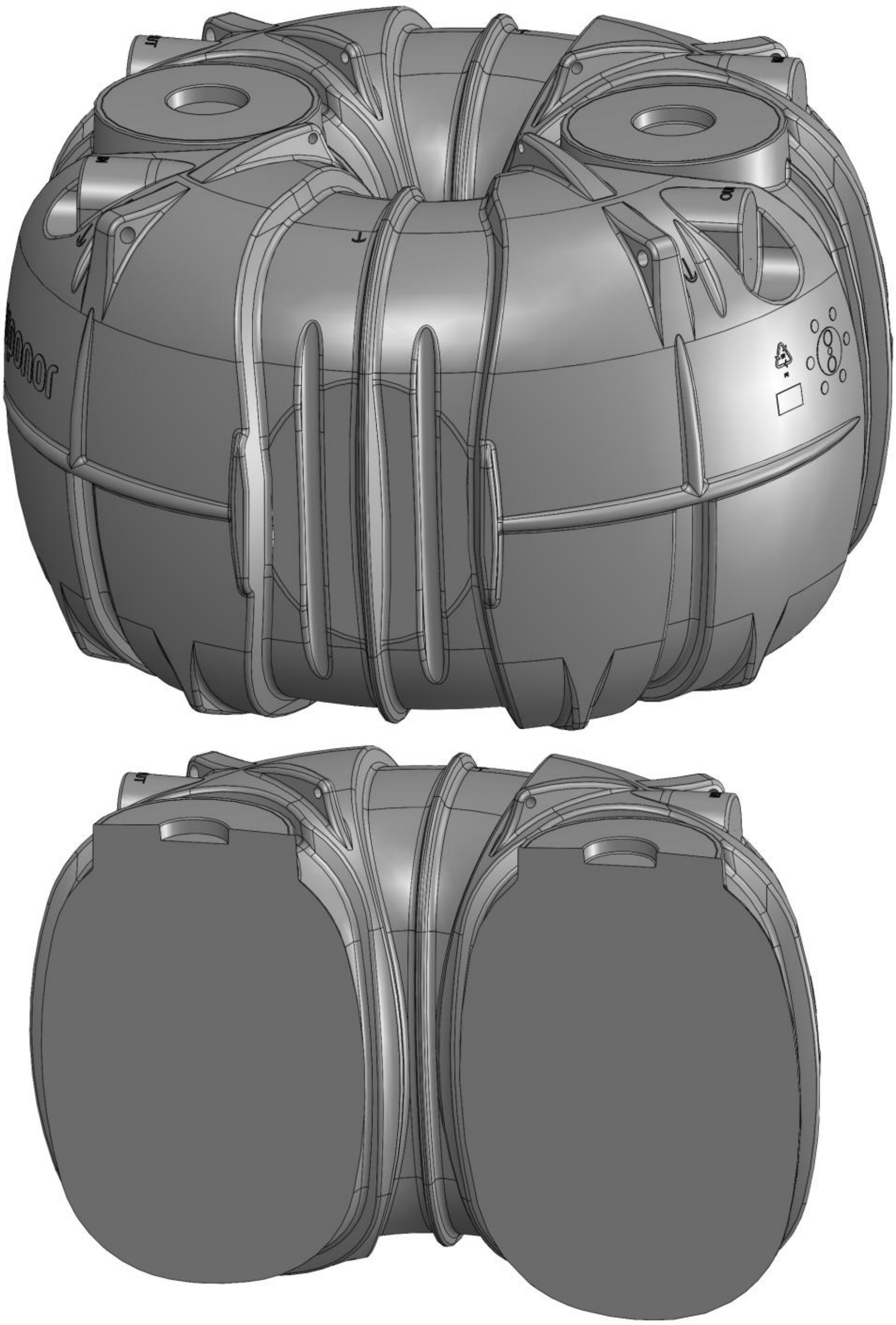

Figure 1: original solid model

The 3D model for analysis (Figure 2) is a surface model which is simplified by removing some small features which won't affect the simulation result, or affect local area result only, but won't affect the overall result. These features increase the mesh numbers and calculation time a lot.

Figure 2: simplified model for analysis

2. Analysis setup

2.1. Analysis type

Analysis type is geometrically and materially nonlinear static structural analysis.

2.2. Material model

The raw material of the tank is Polyethylenne for roto-mould. Currently raw material (Total M4041 and Lupolen 4021) from 2 suppliers are used in Uponor. Based on the datasheet from suppliers, they have only slight differences in major properties.

Typical Properties	Nominal Value	Units	Test Method
Physical			
Melt Flow Rate, (190 °C/2.16 kg)	4.0	g/10 min	ISO 1133-1
Density	0.9395	g/cm³	ISO 1183-1
Mechanical			
Tensile Modulus	750	MPa	ISO 527-1, -2
Tensile Stress at Yield	19	MPa	ISO 527-1, -2
Tensile Strain at Break	> 450	%	ISO 527-1, -2
Tensile Strain at Yield	9	%	ISO 527-1, -2
Environmental Stress Crack Resistance, F_{50}	> 1000	hr	ASTM D1693
Note: Cond. B, 10% Arkopal N100			

Table 1: Datasheet of Lupolen 4021

Property	Method	Unit	Typical value (*)
Density	ISO 1183	g/cm³	0.940
Melt Flow Rate (190°C/2.16kg)	ISO 1133/D	g/10min	4
Melting Point	ISO 11357	°C	126
Tensile Strength at yield	ISO 527-2	MPa	21
Tensile Strength at break	ISO 527-2	MPa	21
Elongation Strength at yield	ISO 527-2	%	11
Elongation Strength at break	ISO 527-2	%	800
Flexural Modulus	ISO 178	MPa	730

Table 2: Datasheet of Total M4041

The material model is multi-linear plastic. Raw material suppliers use different method to address the modulus. Here we use their “Tensile Modulus” and “Flexural Modulus” as the short-term Young’s Modulus. Since the supplier cannot provide the long-term Modulus, to keep a safe factor, based on the experience of Uponor practice, use 1/3 of the original modulus as long term one. Material properties are defined as below (Table 3). For this analysis, long term data will be applied.

Material	*PE for roto-mould*
Young’s Modulus (short term)	*750/730 MPa*
Young’s Modulus (long term)	*240MPa*
Poisson’s (short term)	*0,42*
Poisson’s (long term)	*0,45*

Table 3: Material properties used for calculation

The tensile strength from the raw material supplier is 19MPa and 21MPa. Based on Uponor practice, the stress-strain curves (Figure 3) vary for different strain rates. The stress-strain curve for this analysis is drawn in red.

The related stress-strain data in Figure 3 is shown in Table 4.

Stress (MPa)	***Strain***
0	*0.0%*
7.5	*7.5%*
14.5	*35%*

Table 4: Stress-Strain data

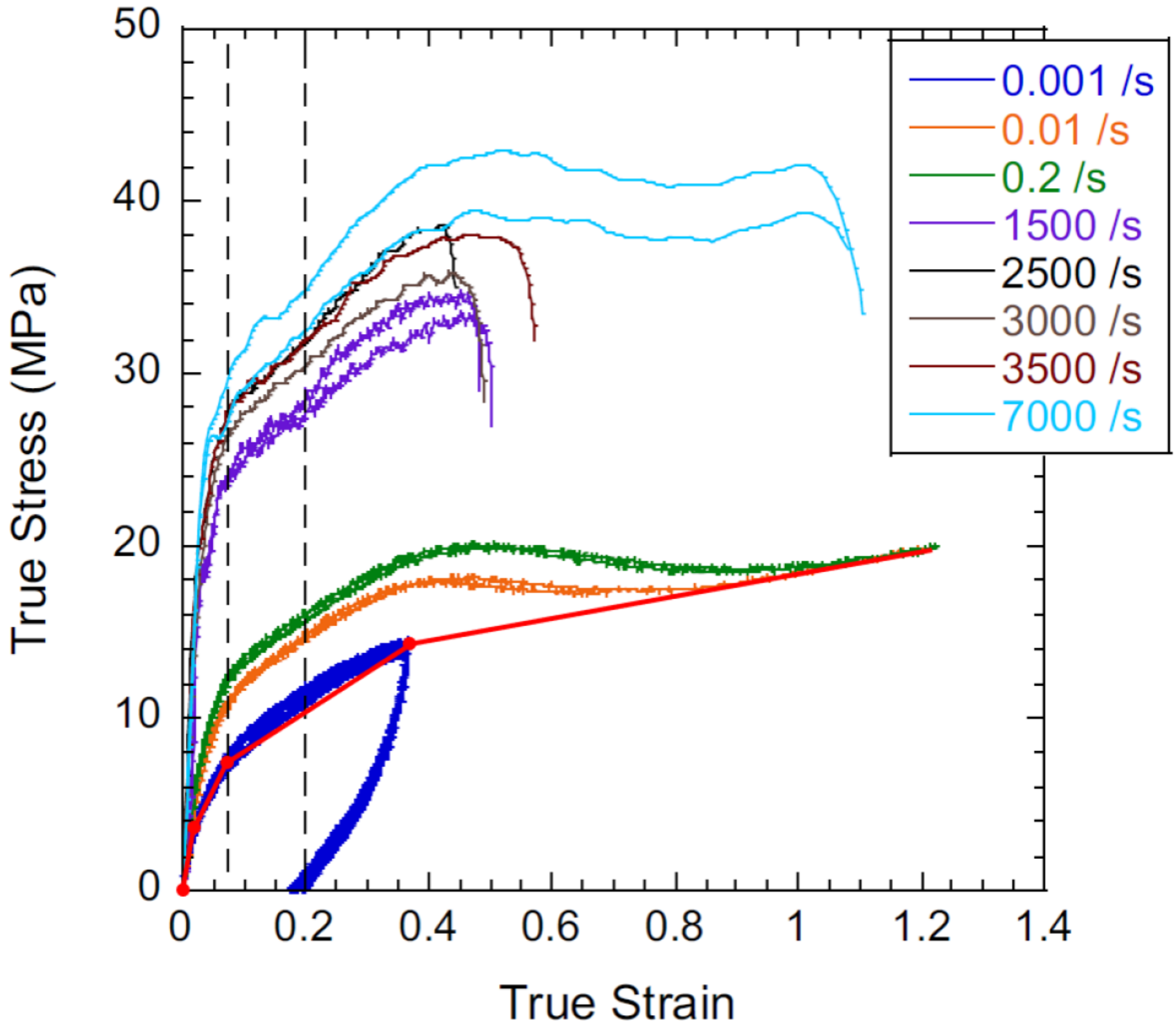

Figure 3: Stress-Strain curve

2.3. Mesh

Surface model is used as the geometry for analysis. Wall thickness is set to 11mm per the design intend.

The mesh is using linear surface elements. Element size set to 10mm. All others keep default settings.

Total nodes are 221,267 and elements are 222,576 accordingly. (Figure 4)

Figure 4: mesh elements

2.4. Boundary conditions

To perform the FEM calculation, the tank body needs to be constrained for the X-Y-Z freedoms.

The coordinate system is to set Y upwards. -Y is the gravity direction. XZ is the plane parallel to ground surface in horizontal.

Set the 4 bottom edges of the support ribs as the support in Y direction to minimize the impact on the rest of the body. (Refer to Figure 5) Leave the XY direction free.

Set the surfaces interface to the inlet pipe as the XZ displacement constrains. The inlet pipe is considered to be rigid. the displacement in XZ direction is very small compared to the tank. (Refer to Figure 5) Leave the Y direction free.

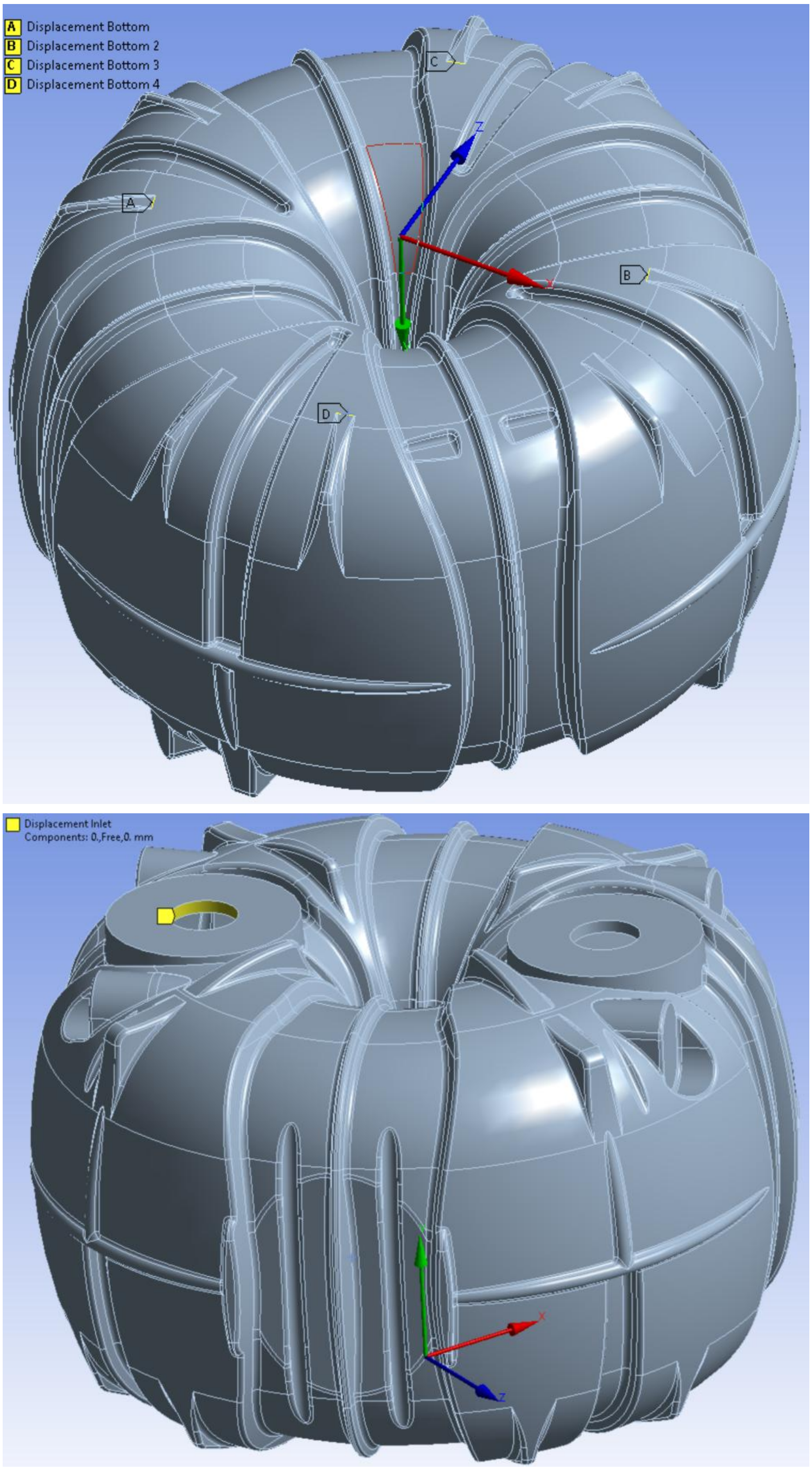

Figure 5: Boundary conditions

The concaved spaces will be filled by sands after installation. And the sands will provide additional support to the surfaces around. According to Uponor experience, apply 5N/mm3 elastic support if the sands are well filled. Here 0,5N/mm3 elastic support applied to the inner surfaces (marked in Figure 6) as these areas may not be well filled by sands (install instruction addressed that need to check the back fill status at these areas). The elastic support on the rest of surfaces is not considered in this calculation.

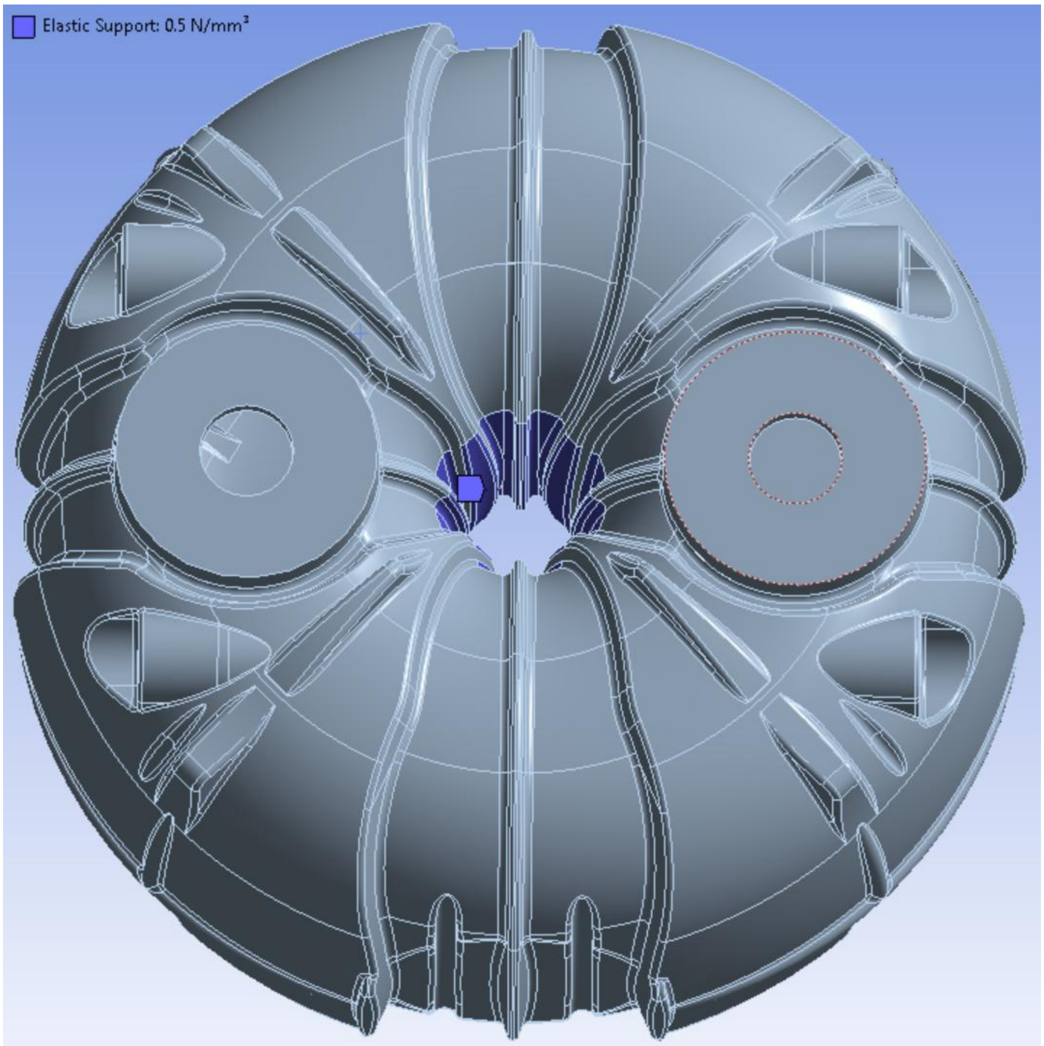

Figure 6: Elastic Support

2.5. Loads

According to EN 12566-1:2016, all the loads applied is shown in Figure 7.

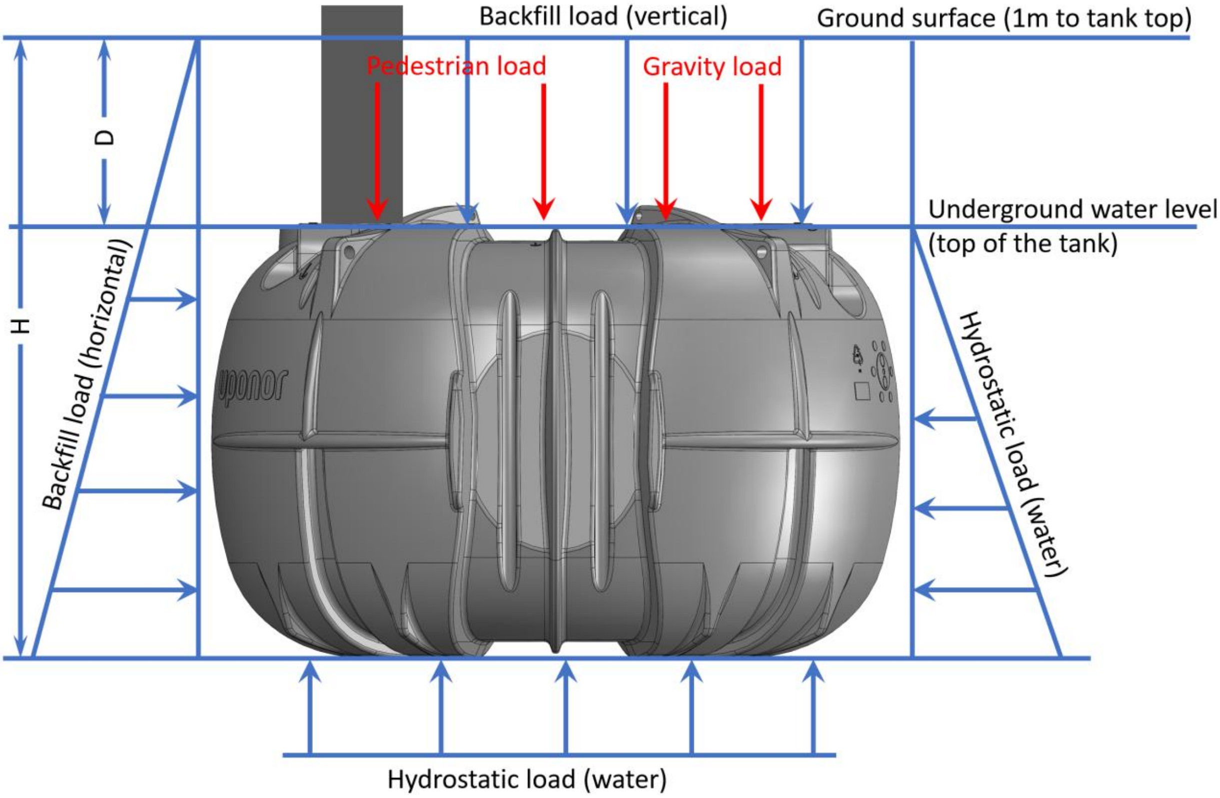

Figure 7: Loads

- Backfill loads (EN 12566-3:2016 5.1.2.2)
  Vertical component: H x 18 (expressed in kN/m2), where 18 (kN/m3) is the specific weight of the soil and H is the height (in meter) of backfill.
  Apply a hydrostatic load to the top surfaces of the tank with a Fluid Density of 1800Kg/m3 to simulate the vertical component.
  Horizontal component: K x D x 18 (expressed in kN/m2), where D (in meter) is the distance from the ground level to the point where the load applies. K coefficient of gravel is 0,27.
  Apply a hydrostatic load to the side surfaces of the tank with a Fluid Density of 486Kg/m3 to simulate the horizontal component.

- Hydrostatic loads (EN 12566-3:2016 5.1.2.3)

The vertical and horizontal component are the same according to the standard.
Apply a hydrostatic load to all outer surfaces with a Fluid Density of 1000Kg/m3 to simulate the hydrostatic load of underground water.

- Pedestrian loads (EN 12566-1:2016 5.1.2.4)
  According to the standard, for pedestrian loads a value of 2,5kN/m2 shall be considered in calculation only when the height of the backfill is less than or equal to 1m.
  Apply a pressure load of 2.5kN/m2 to the top surfaces of the tank to address the pedestrian loads.

3. Analysis results

Result of equivalent stress and total deformation are shown here as the analysis output. Equivalent stress is to define the strength of the model, and total deformation is to define the displacement of the elements.

3.1. Equivalent stress

According to the Stress-strain curve, the equivalent stress is divided into 3 segments.
0-7,5 MPa: marked in blue, represents the safe area.
7,5-14,5 MPa: marked in green, represents low risk area.
>14,5 MPa: marked in red, represents high risk area.

Simulation shows most of the areas are safe (blue surfaces in Figure 8). Low risk areas are scattered and relatively small (green surfaces in Figure 8). High risk areas are located at the corner of the bottom ribs (red surfaces in Figure 8). The high stress concentration is caused by the constrains set in Figure 5. These areas are small and considered to be ignored.

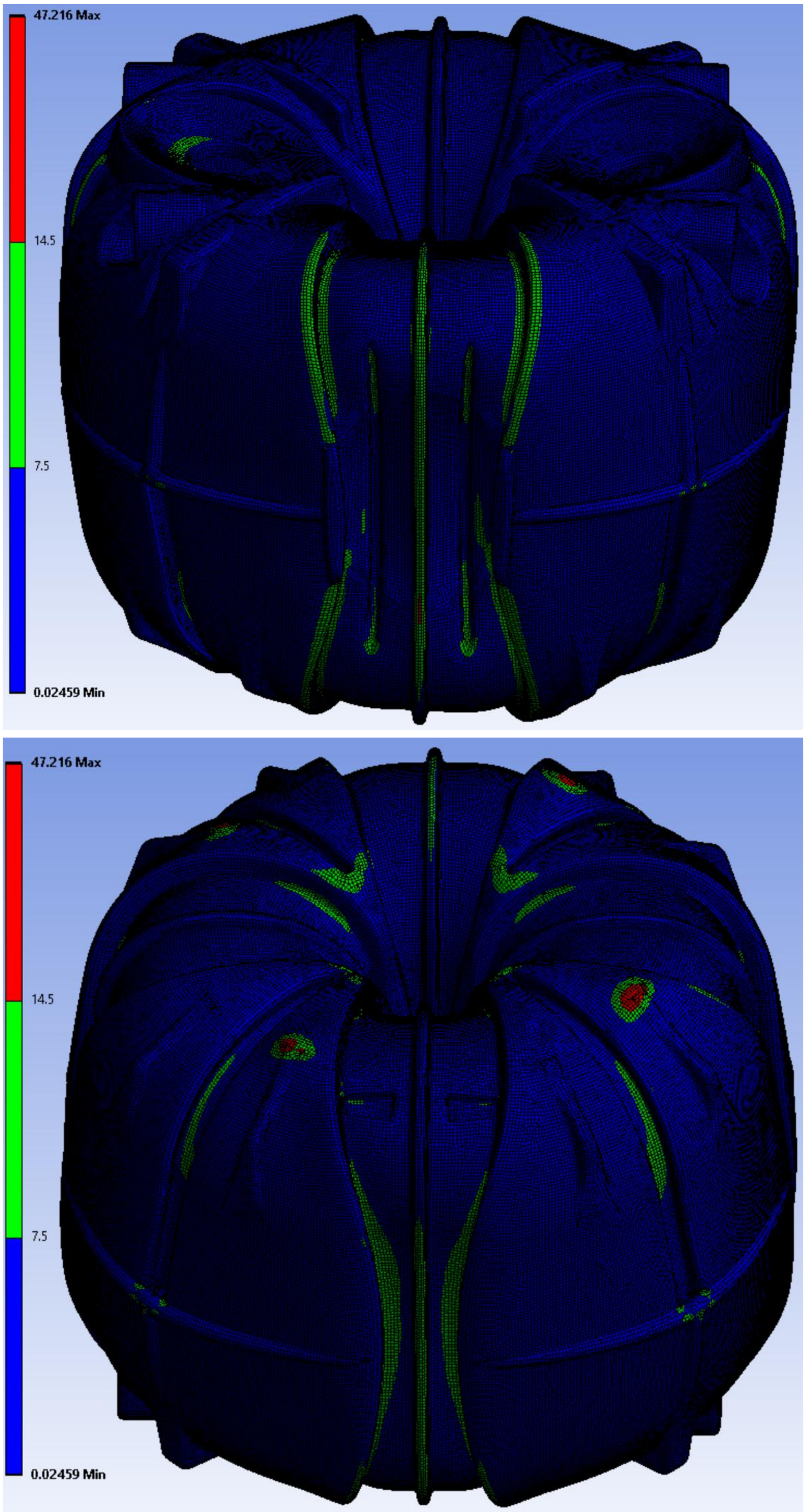

Figure 8: Equivalent stress overview

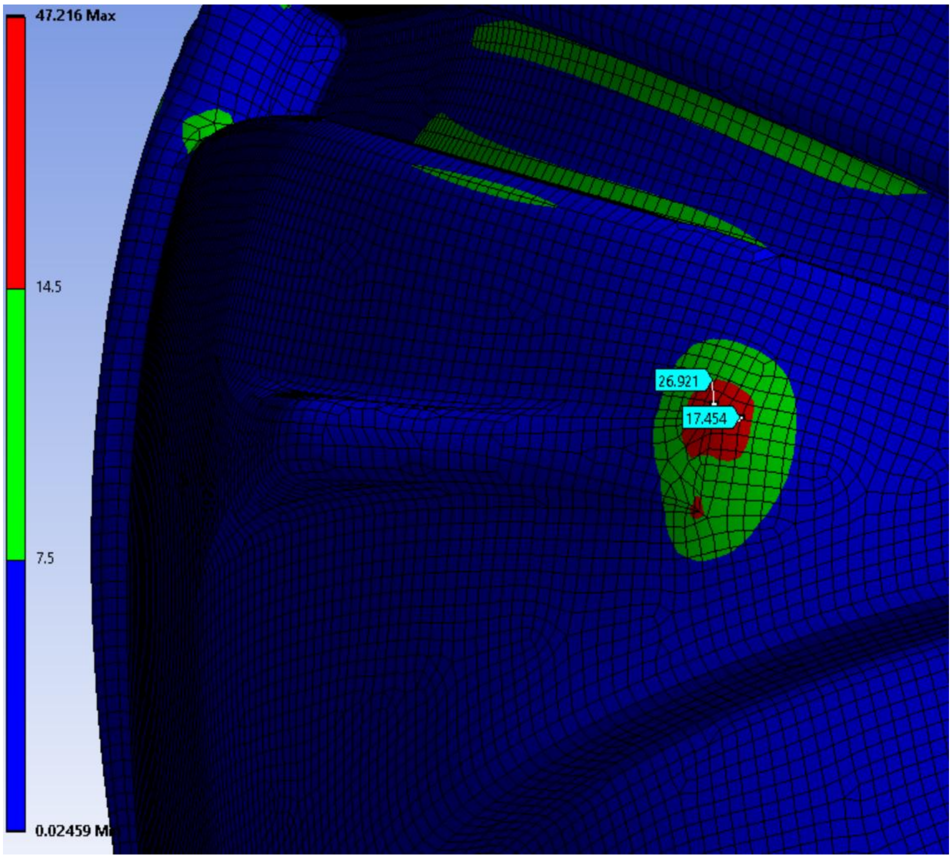

Figure 9: High risk area

3.2. Total Deformation

Total deformation overview is shown in Figure 10. Simulation shows the majority of the area has a deformation less than 120mm. Considering the overall size of the tank, this should be acceptable.

Treat the tank as a cylinder with diameter of 2400mm and height of 1490mm. According to the result, take 60mm as the average increase in height direction (Y direction in Figure 12), 60mm as the average decrease in radius direction (combine X and Z direction in Figure 12&14). The rough calculation of total volume lose is around 6%. As a holding tank, there will be water filled inside for almost all the time, the actual situation will be much better than this calculation.

This holding tank has only one inlet (Figure 10). The inlet pipe will reinforce the structure in XZ direction at the inlet area. Calculation shows that there will be around 20mm displacement in Y direction. This is much less than the engagement of the inlet pipe and inlet hole in Y direction. So, it's considered to be safe.

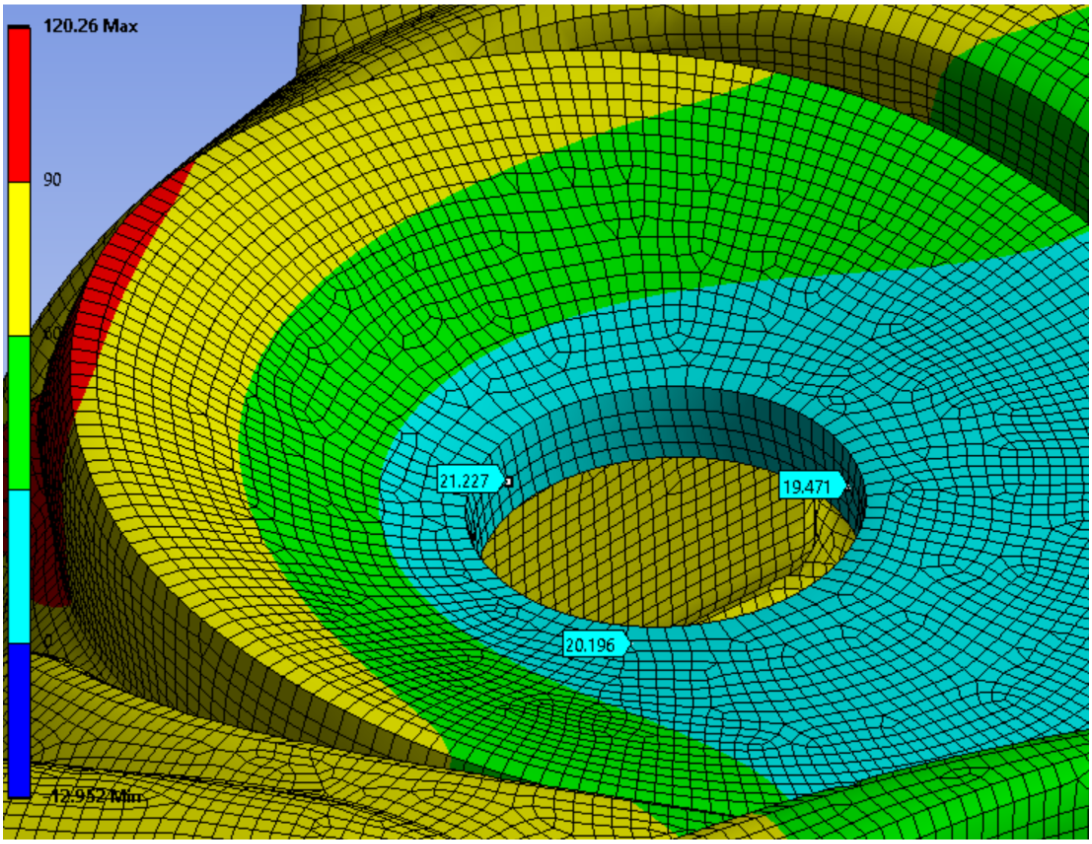

Figure 10: inlet displacement in Y directions

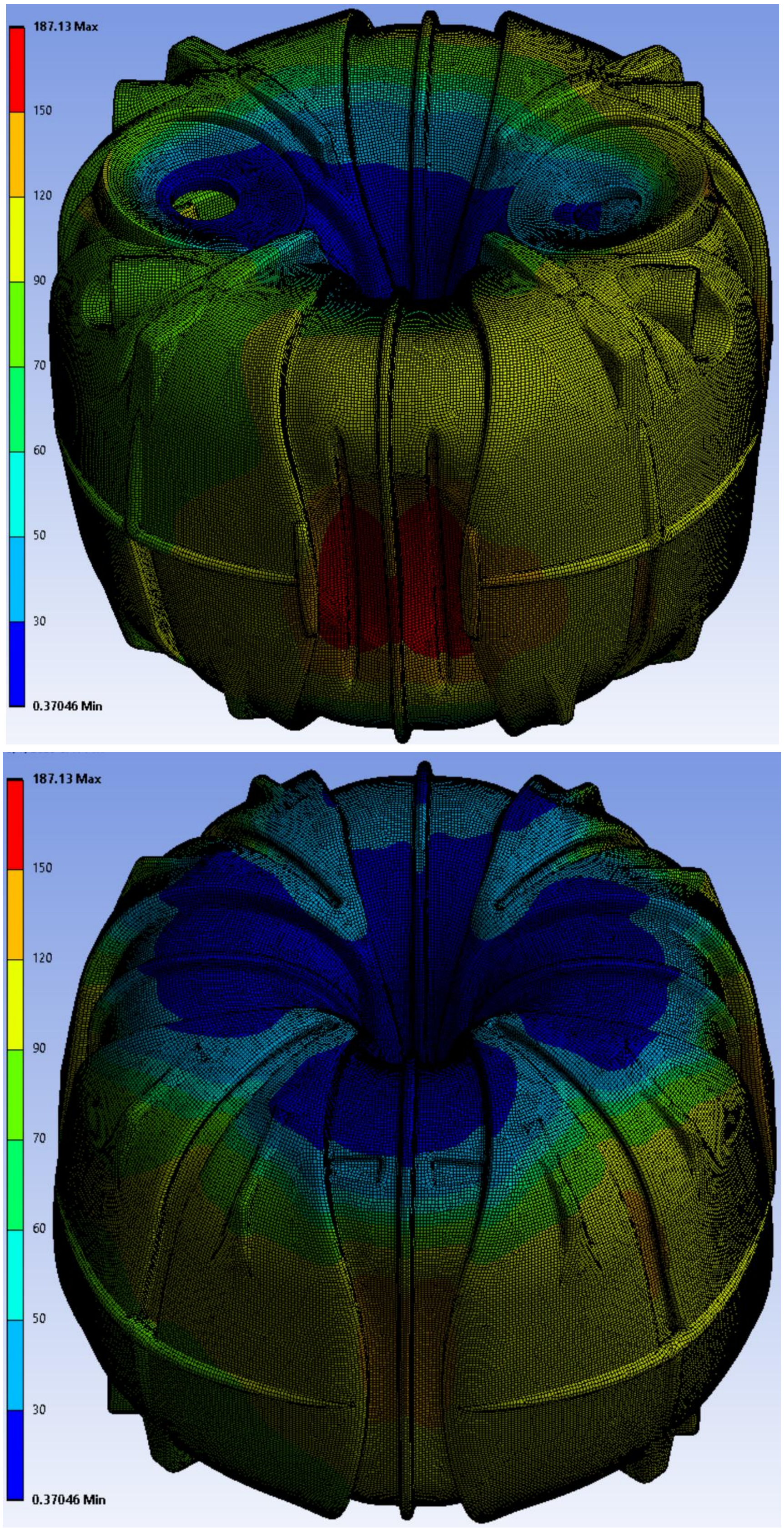

Figure 11: Total deformation

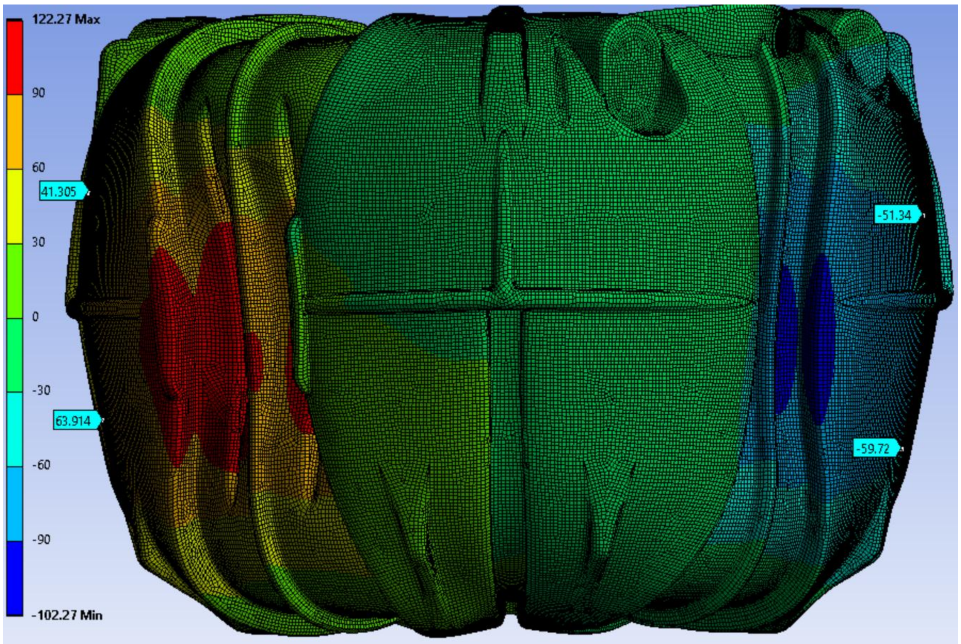

Figure 12: Deformation in X directions

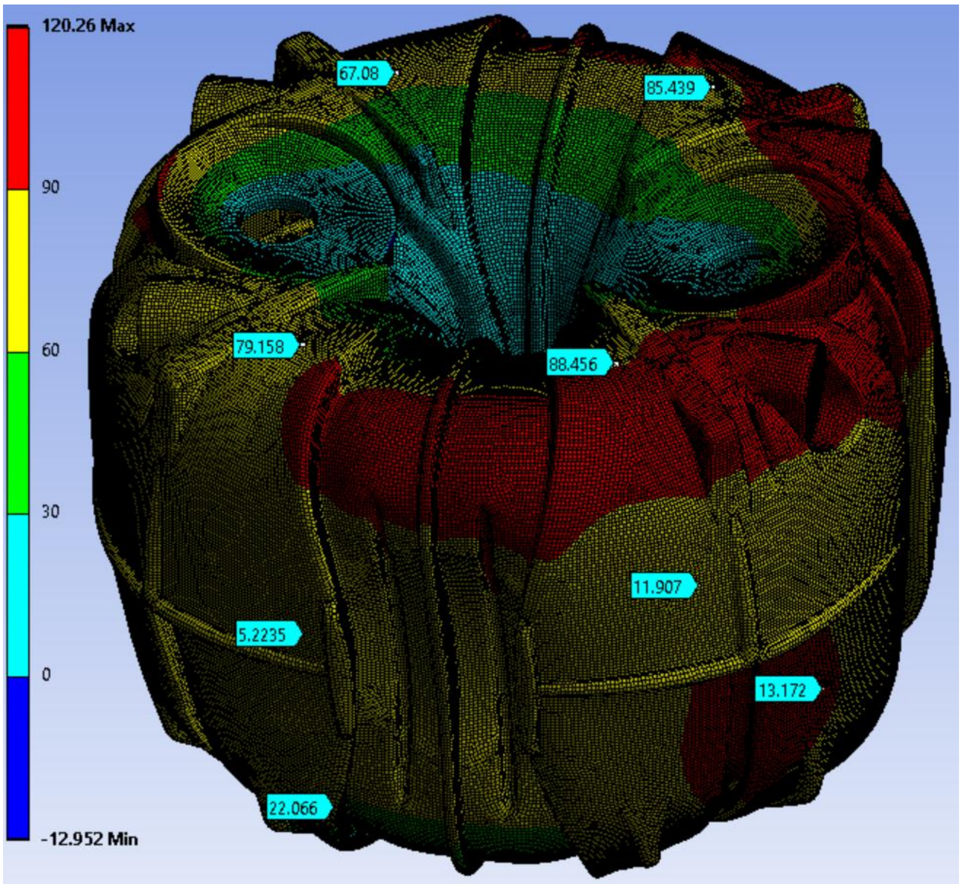

Figure 13: Deformation in Y directions

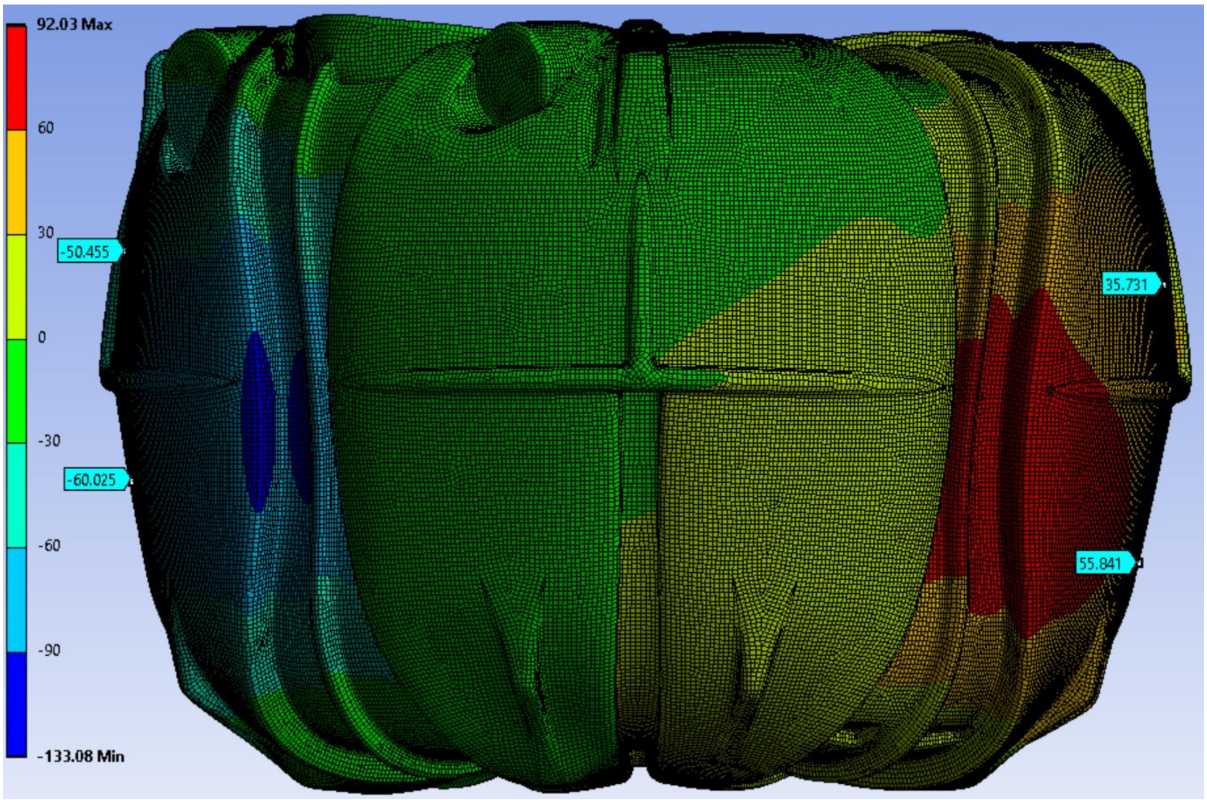

Figure 14: Deformation in Z directions

4. Conclusions

According to the standard of EN 12566-1:2016 D.6.3, for holding tanks made with materials other than concrete or GRP, criteria is as below:

- *the variation of the volume of the septic tank shall be lower than 20% of the internal volume of the septic tank;*
- *the movement of inlet, outlet and interconnecting pipe works shall not lead to a lack of watertightness.*

In real case, the tank is buried underground and surrounded by sands/soils which provide extra support to the structure. Most of the time, the tank is filled by wastewater which will neutralize the external pressure applied by underground water. All these factors make the tank even safer than what this FEM calculation indicated.

Calculation shows that the tank will withstand the designed forces with a safe margin, and it can thus be concluded that according to the calculation the tank will comply to EN 12566-1:2016 requirements.

5. References

- Standard of EN 12566-1:2016
- Standard of EN 12566-3:2016
- Material specification: Lupolen 4021
- Material specification: Total Lumicene 4041
- Simulation report from Ansys 2021

Version of history:

Revision	Description	Date
1,0	Release for Declaration of Conformity.	07/03/2025

Technical Data Sheet

Lupolen 4021 K RM

High Density Polyethylene

Product Description

Lupolen 4021 K RM is a new generation hexene linear high density polyethylene for rotomolding. Typical customer applications include large tanks including agricultural and chemical storage containers and underground and infrastructure applications. This product exhibits excellent ESCR and high impact strength at low temperatures. *Lupolen* 4021 K RM is a UV-stabilized and pelletized polymer. Tests have shown that this material is resisting against the harmful effect of biodiesel fuel*. It is not intended for use in medical and pharmaceutical applications.

* Resistance is based on our latest patented technology

Regulatory Status

For regulatory compliance information, see *Lupolen* 4021 K RM Product Stewardship Bulletin (PSB) and Safety Data Sheet (SDS).

This grade is supported for use in drinking water applications.

Status	Commercial: Active
Availability	Africa-Middle East; Asia-Pacific; Europe
Application	Heating Oil Tanks; Intermediate Bulk Containers; Tanks, Industrial
Market	Industrial Packaging; Industrial, Building & Construction
Processing Method	Rotomolding
Attribute	Good Processability; High ESCR (Environmental Stress Cracking Resistance); Low Temperature Impact Resistance; Low Warpage

Typical Properties	Nominal Value	Units	Test Method
Physical			
Melt Flow Rate, (190 °C/2.16 kg)	4.0	g/10 min	ISO 1133-1
Density	0.9395	g/cm³	ISO 1183-1
Mechanical			
Tensile Modulus	750	MPa	ISO 527-1, -2
Tensile Stress at Yield	19	MPa	ISO 527-1, -2
Tensile Strain at Break	> 450	%	ISO 527-1, -2
Tensile Strain at Yield	9	%	ISO 527-1, -2
Environmental Stress Crack Resistance, F_{50}	> 1000	hr	ASTM D1693
Note: Cond. B, 10% Arkopal N100			
FNCT, (6.0 MPa, 2% Arkopal N100, 50 °C)	50	hr	ISO 16770
Impact			
Tensile Impact Strength	120	kJ/m²	ISO 8256
Note: notched, type 1, method A, -30 °C			
Thermal			
Vicat Softening Temperature, (A/50)	114	°C	ISO 306
Processing Parameters			

Peak Internal Air Temperature (PIAT)	180-210	°C
Recommended range. Note: PIAT should not exceed 225 °C.		

Notes

These are typical property values not to be construed as specification limits.

Processing Techniques

Users should determine the conditions necessary to obtain optimum product properties and suitability of the product for the intended application.

In cases where higher temperatures are required, please contact your appropriate technical contact for support.

Further Information

Health and Safety:
The resin is manufactured to the highest standards, but special requirements apply to certain applications such as food end-use contact and direct medical use. For specific information on regulatory compliance contact your local representative.

Workers should be protected from the possibility of skin or eye contact with molten polymer. Safety glasses are suggested as a minimal precaution to prevent mechanical or thermal injury to the eyes.

Molten polymer may be degraded if it is exposed to air during any of the processing and off-line operations. The products of degradation may have an unpleasant odor. In higher concentrations they may cause irritation of the mucus membranes. Fabrication areas should be ventilated to carry away fumes or vapours. Legislation on the control of emissions and pollution prevention should be observed.

The resin will burn when supplied with excess heat and oxygen. It should be handled and stored away from contact with direct flames and/or ignition sources. While burning, the resin contributes high heat and may generate a dense black smoke.

Recycled resins may have previously been used as packaging for, or may have otherwise been in contact with, hazardous goods. Converters are responsible for taking all necessary precautions to ensure that recycled resins are safe for continued use.

For further information about safety in handling and processing please refer to the Safety Data Sheet.

Conveying:
Conveying equipment should be designed to prevent production and accumulation of fines and dust particles that are contained in polymer resins. These particles can under certain conditions pose an explosion hazard. Conveying systems should be grounded, equipped with adequate filters and regularly inspected for leaks.

Storage:
The resin is packed in 25 kg bags, octabins or bulk containers protecting it from contamination. If it is stored under certain conditions, i. e. if there are large fluctuations in ambient temperature and the atmospheric humidity is high, moisture may condense inside the packaging. Under these circumstances, it is recommended to dry the resin before use. Unfavorable storage conditions may also intensify the resin's slight characteristic odor.

Resin should be protected from direct sunlight, temperatures above 40°C and high atmospheric humidity during storage. Higher storage temperatures may reduce the storage time.

The information submitted is based on our current knowledge and experience. In view of the many factors that may affect processing and application, these data do not relieve processors of the responsibility of carrying out their own tests and experiments; neither do they imply any legally binding assurance of certain properties or of suitability for a specific purpose. This information does not remove the obligation of the customer to inspect the material on arrival and notify us of any faults immediately. It is the responsibility of those to whom we supply our products to ensure that any proprietary rights and existing laws and legislation are observed.

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TotalEnergies

Refining & Chemicals
Polymers

Polyethylene Lumicene® mPE M 4041 UV

Technical data sheet
Metallocene Polyethylene ROTOMOULDING
Produced in Europe

Description

Lumicene® mPE M 4041 UV is a new generation metallocene medium density polyethylene (mMDPE) with hexene as comonomer.

Lumicene® mPE M 4041 UV is intended for the manufacture of large rotomoulded items.

Lumicene® mPE M 4041 UV is a natural grade available in pellets form.

Characteristics

Property	Method	Unit	Typical value (*)
Density	ISO 1183	g/cm³	0.940
Melt Flow Rate (190°C/2.16kg)	ISO 1133/D	g/10min	4
Melting Point	ISO 11357	°C	126
Tensile Strength at yield	ISO 527-2	MPa	21
Tensile Strength at break	ISO 527-2	MPa	21
Elongation Strength at yield	ISO 527-2	%	11
Elongation Strength at break	ISO 527-2	%	800
Flexural Modulus	ISO 178	MPa	730

(*) Data not intended for specification purposes

Handling and storage

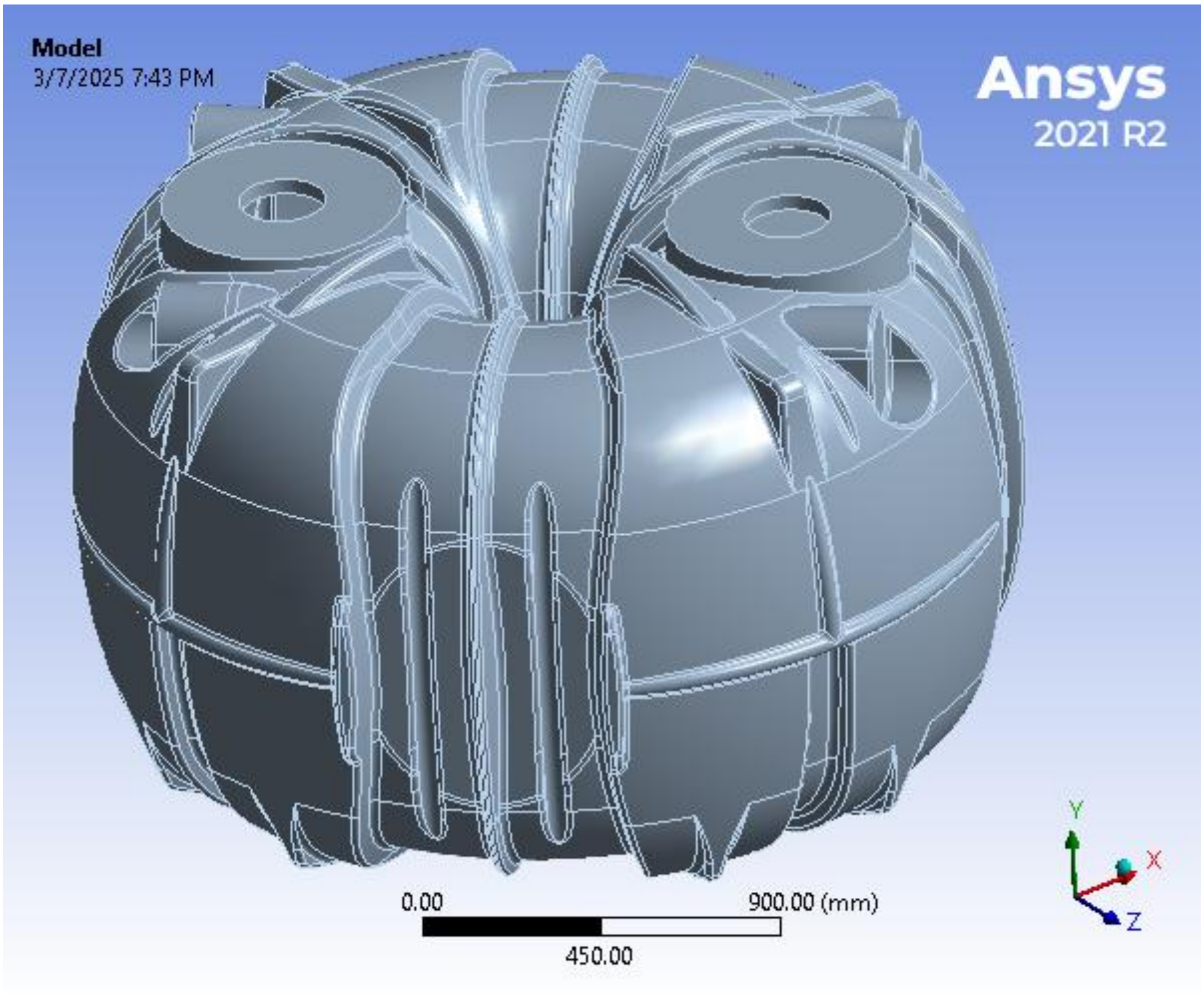
Please refer to the safety data sheet (SDS) for handling and storage information. It is advisable to convert the product within one year after delivery provided storage conditions are used as given in the SDS of our product. SDS may be obtained from the website: www.polymers.totalenergies.com.

Polyethylene

TOTALENERGIES ONE TECH BELGIUM
Zone Industrielle C
B-7181 Feluy
Belgium

Project*

First Saved	Tuesday, December 31, 2024
Last Saved	Friday, March 7, 2025
Product Version	2021 R2
Save Project Before Solution	No
Save Project After Solution	No



uponor

Contents

Units

TABLE 1

Unit System	Metric (mm, kg, N, s, mV, mA) Degrees rad/s Celsius
Angle	Degrees
Rotational Velocity	rad/s
Temperature	Celsius

Model (A4)

Geometry

TABLE 2
Model (A4) > Geometry

Object Name	*Geometry*
State	Fully Defined
Definition	
Source	C:\John\TorusII\TorusII_simplified.SLDPRT
Type	SOLIDWORKS
Length Unit	Meters
Element Control	Program Controlled
Display Style	Body Color
Bounding Box	
Length X	2450. mm
Length Y	1562.6 mm
Length Z	2450. mm
Properties	

Volume	2.2613e+008 mm³
Mass	212.57 kg
Surface Area(approx.)	2.0558e+007 mm²
Scale Factor Value	1.
2D Tolerance	Default (1.e-005)
Statistics	
Bodies	1
Active Bodies	1
Nodes	221267
Elements	222576
Mesh Metric	None
Update Options	
Assign Default Material	No
Basic Geometry Options	
Solid Bodies	Yes
Surface Bodies	Yes
Line Bodies	No
Parameters	Independent
Parameter Key	ANS;DS
Attributes	No
Named Selections	No
Material Properties	No
Advanced Geometry Options	
Use Associativity	Yes
Coordinate Systems	No
Reader Mode Saves Updated File	No
Use Instances	Yes
Smart CAD Update	Yes
Compare Parts On Update	No
Analysis Type	3-D
Mixed Import Resolution	None
Import Facet Quality	Source
Clean Bodies On Import	No
Stitch Surfaces On Import	None
Decompose Disjoint Geometry	Yes
Enclosure and Symmetry Processing	Yes

TABLE 3
Model (A4) > Geometry > Parts

Object Name	*TorusII_simplified@Fillet314*
State	Meshed
Graphics Properties	
Visible	Yes
Transparency	1
Definition	
Suppressed	No
Dimension	3D
Model Type	Shell
Stiffness Behavior	Flexible

Stiffness Option	Membrane and Bending
Coordinate System	Default Coordinate System
Reference Temperature	By Environment
Thickness	11. mm
Thickness Mode	Manual
Offset Type	Middle
Treatment	None
Material	
Assignment	Polyethylene
Nonlinear Effects	Yes
Thermal Strain Effects	Yes
Bounding Box	
Length X	2450. mm
Length Y	1562.6 mm
Length Z	2450. mm
Properties	
Volume	2.2613e+008 mm³
Mass	212.57 kg
Centroid X	0.50508 mm
Centroid Y	769.31 mm
Centroid Z	1.087 mm
Moment of Inertia Ip1	1.5272e+008 kg·mm²
Moment of Inertia Ip2	1.8915e+008 kg·mm²
Moment of Inertia Ip3	1.4972e+008 kg·mm²
Surface Area(approx.)	2.0558e+007 mm²
Statistics	
Nodes	221267
Elements	222576
Mesh Metric	None

TABLE 4
Model (A4) > Materials

Object Name	*Materials*
State	Fully Defined
Statistics	
Materials	1
Material Assignments	0

Coordinate Systems

TABLE 5
Model (A4) > Coordinate Systems > Coordinate System

Object Name	*Global Coordinate System*
State	Fully Defined
Definition	
Type	Cartesian
Coordinate System ID	0.
Origin	
Origin X	0. mm

Origin Y	0. mm
Origin Z	0. mm
Directional Vectors	
X Axis Data	[1. 0. 0.]
Y Axis Data	[0. 1. 0.]
Z Axis Data	[0. 0. 1.]

Mesh

TABLE 6
Model (A4) > Mesh

Object Name	*Mesh*
State	Solved
Display	
Display Style	Use Geometry Setting
Defaults	
Physics Preference	Mechanical
Element Order	Program Controlled
Element Size	10.0 mm
Sizing	
Use Adaptive Sizing	Yes
Resolution	Default (2)
Mesh Defeaturing	Yes
Defeature Size	Default
Transition	Fast
Span Angle Center	Coarse
Initial Size Seed	Assembly
Bounding Box Diagonal	3800.9 mm
Average Surface Area	13280 mm²
Minimum Edge Length	2.0481e-003 mm
Quality	
Check Mesh Quality	Yes, Errors
Error Limits	Aggressive Mechanical
Target Quality	Default (0.050000)
Smoothing	Medium
Mesh Metric	None
Inflation	
Use Automatic Inflation	None
Inflation Option	Smooth Transition
Transition Ratio	0.272
Maximum Layers	2
Growth Rate	1.2
Inflation Algorithm	Pre
View Advanced Options	No
Batch Connections	
Mesh Based Connection	No
Advanced	
Number of CPUs for Parallel Part Meshing	Program Controlled
Straight Sided Elements	No

Rigid Body Behavior	Dimensionally Reduced
Triangle Surface Mesher	Program Controlled
Topology Checking	Yes
Use Sheet Thickness for Pinch	No
Pinch Tolerance	Please Define
Generate Pinch on Refresh	No
Sheet Loop Removal	No
Statistics	
Nodes	221267
Elements	222576

Named Selections

TABLE 7
Model (A4) > Named Selections > Named Selections

Object Name	*TopSurfaces*	*SideSurfaces*	*OutSurfaces*
State	Fully Defined		
Scope			
Scoping Method	Geometry Selection		
Geometry	444 Faces	768 Faces	1546 Faces
Definition			
Send to Solver	Yes		
Protected	Program Controlled		
Visible	Yes		
Program Controlled Inflation	Exclude		
Statistics			
Type	Manual		
Total Selection	444 Faces	768 Faces	1546 Faces
Surface Area	4.8853e+006 mm²	1.4165e+007 mm²	2.0517e+007 mm²
Suppressed	0		
Used by Mesh Worksheet	No		

Static Structural (A5)

TABLE 8
Model (A4) > Analysis

Object Name	*Static Structural (A5)*
State	Solved
Definition	
Physics Type	Structural
Analysis Type	Static Structural
Solver Target	Mechanical APDL
Options	
Environment Temperature	22. °C
Generate Input Only	No

TABLE 9
Model (A4) > Static Structural (A5) > Analysis Settings

Object Name	*Analysis Settings*

State	Fully Defined
Step Controls	
Number Of Steps	1.
Current Step Number	1.
Step End Time	1. s
Auto Time Stepping	Program Controlled
Solver Controls	
Solver Type	Program Controlled
Weak Springs	Off
Solver Pivot Checking	Program Controlled
Large Deflection	Off
Inertia Relief	Off
Quasi-Static Solution	Off
Restart Controls	
Generate Restart Points	Program Controlled
Retain Files After Full Solve	No
Combine Restart Files	Program Controlled
Nonlinear Controls	
Newton-Raphson Option	Program Controlled
Force Convergence	Program Controlled
Moment Convergence	Program Controlled
Displacement Convergence	Program Controlled
Rotation Convergence	Program Controlled
Line Search	Program Controlled
Stabilization	Program Controlled
Advanced	
Inverse Option	No
Contact Split (DMP)	Off
Output Controls	
Stress	Yes
Surface Stress	No
Back Stress	No
Strain	Yes
Contact Data	Yes
Nonlinear Data	No
Nodal Forces	No
Volume and Energy	Yes
Euler Angles	Yes
General Miscellaneous	No
Contact Miscellaneous	No
Store Results At	All Time Points
Result File Compression	Program Controlled
Analysis Data Management	
Solver Files Directory	C:\John\TorusII\Tank5m3_files\dp0\SYS\MECH\
Future Analysis	None
Scratch Solver Files Directory	
Save MAPDL db	No
Contact Summary	Program Controlled
Delete Unneeded Files	Yes

Nonlinear Solution	No
Solver Units	Active System
Solver Unit System	nmm

TABLE 10
Model (A4) > Static Structural (A5) > Accelerations

Object Name	*Standard Earth Gravity*
State	Fully Defined
Scope	
Geometry	All Bodies
Definition	
Coordinate System	Global Coordinate System
X Component	0. mm/s² (ramped)
Y Component	-9806.6 mm/s² (ramped)
Z Component	0. mm/s² (ramped)
Suppressed	No
Direction	-Y Direction

FIGURE 1
Model (A4) > Static Structural (A5) > Standard Earth Gravity

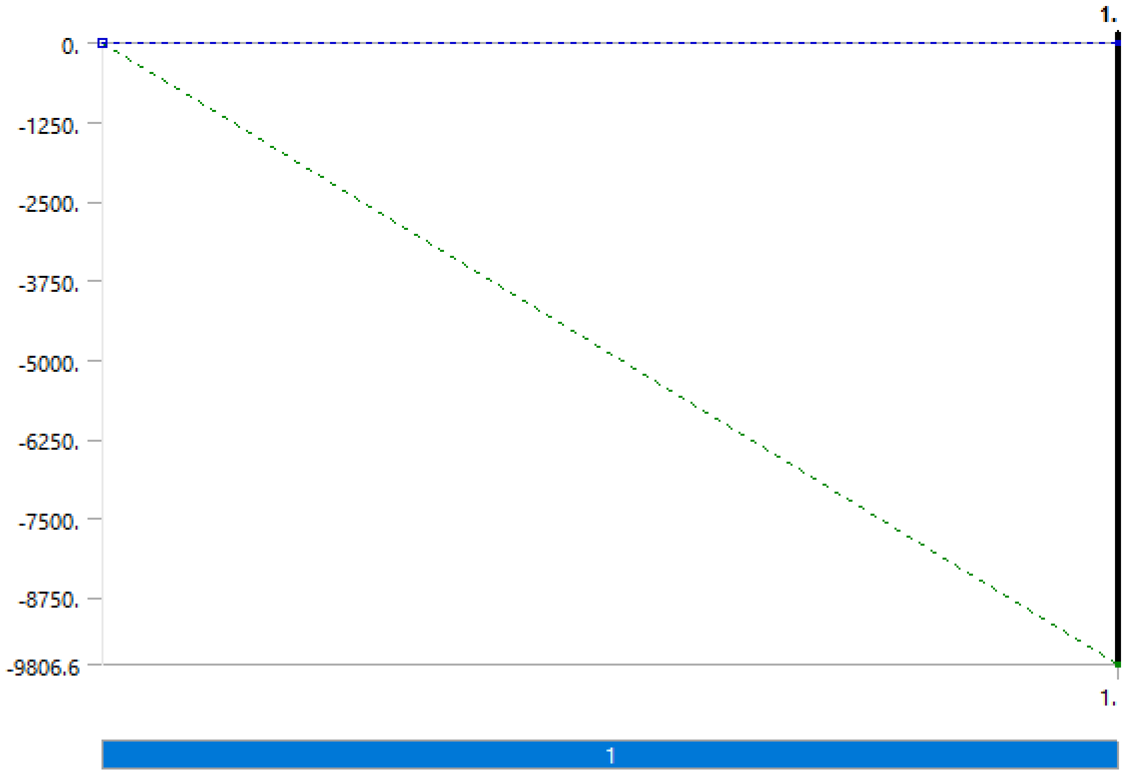


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TABLE 11
Model (A4) > Static Structural (A5) > Loads

Object Name	*Displacement Bottom*	*Displacement Inlet*	*Hydrostatic Pressure Undergroundwater*	*Hydrostatic Pressure*	*Pressure Pedestrian*	*Hydrostatic Pressure*	*Displacement Bottom 2*	*Displacement Bottom 3*	*Displacement Bottom 4*	*Elastic Support*

				Sands side		*Sands top*				
State	Fully Defined									
Scope										
Scoping Method	Geometry Selection		Named Selection				Geometry Selection			
Geometry	1 Edge	1 Face					1 Edge			64 Faces
Named Selection			OutSurfaces	SideSurfaces	TopSurfaces					
Shell Face			Top			Top				
Definition										
Type	Displacement		Hydrostatic Pressure		Pressure	Hydrostatic Pressure	Displacement			Elastic Support
Define By	Components				Vector		Components			
Coordinate System	Global Coordinate System					Global Coordinate System				
X Component	Free	0. mm (ramped)					Free			
Y Component	0. mm (ramped)	Free					0. mm (ramped)			
Z Component	Free	0. mm (ramped)					Free			
Suppressed	No									
Applied By			Surface Effect							
Fluid Density			1.e-006 kg/mm^3	4.86e-007 kg/mm^3		1.314e-006 kg/mm^3				
Loaded Area					Deformed					
Magnitude					2.5e-003 MPa (ramped)					
Direction					Defined					
Foundation Stiffness										0.5 N/mm^3

Hydrostatic Acceleration						
Define By		Vector			Vector	
Magnitude		9800. mm/s² (ramped)			9800. mm/s² (ramped)	
Direction		Defined			Defined	
Free Surface Location						
X Coordinate		0. mm			0. mm	
Y Coordinate		1490. mm	2490. mm		2490. mm	
Z Coordinate		0. mm			0. mm	
Location		Defined			Defined	

FIGURE 2
Model (A4) > Static Structural (A5) > Displacement Bottom

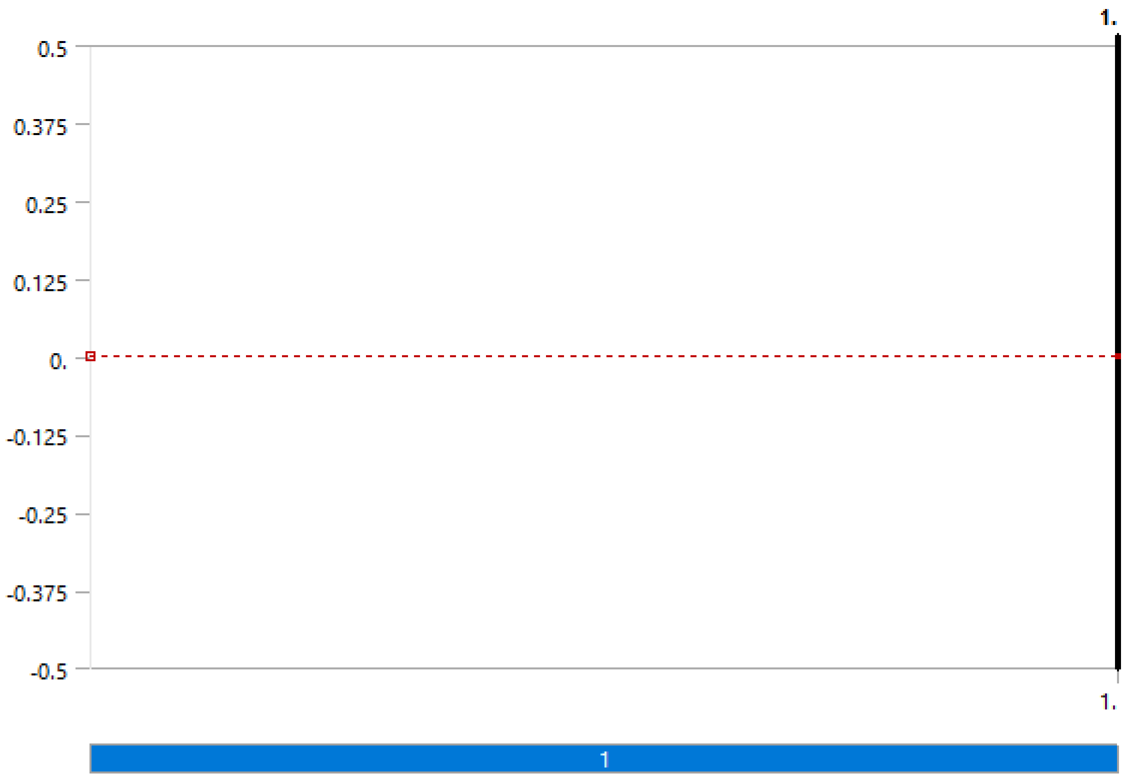

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FIGURE 3
Model (A4) > Static Structural (A5) > Displacement Inlet

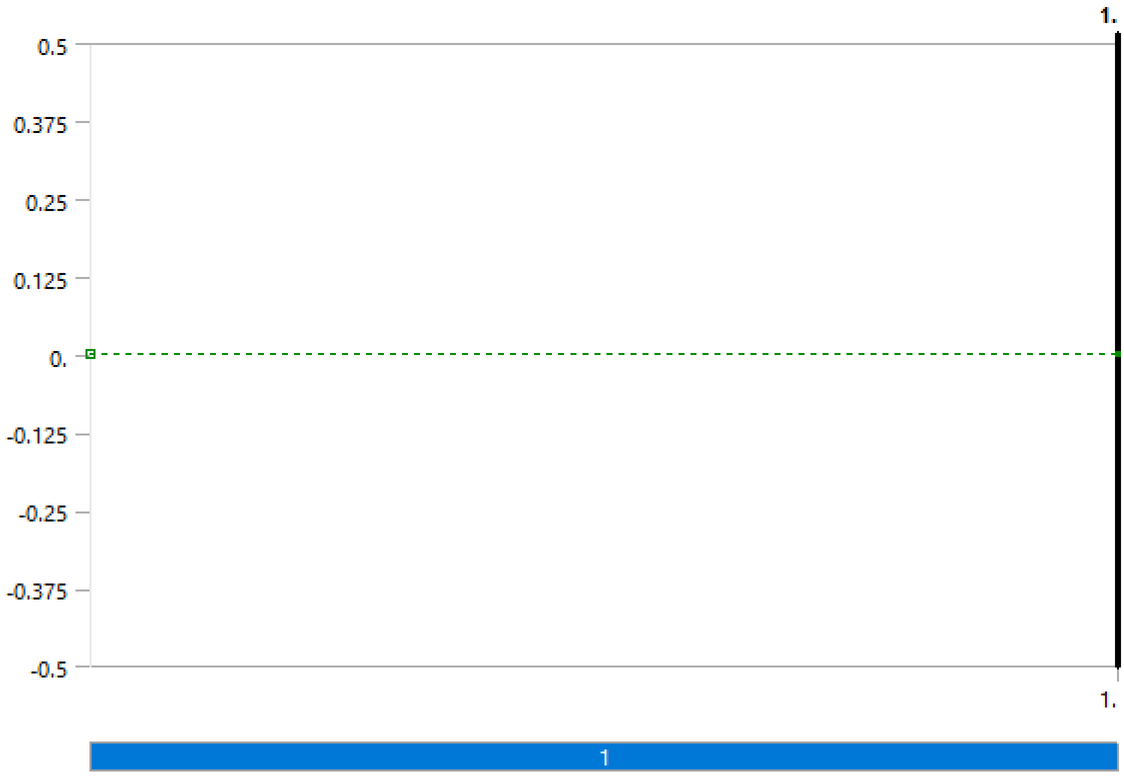

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FIGURE 4
Model (A4) > Static Structural (A5) > Hydrostatic Pressure Undergroundwater

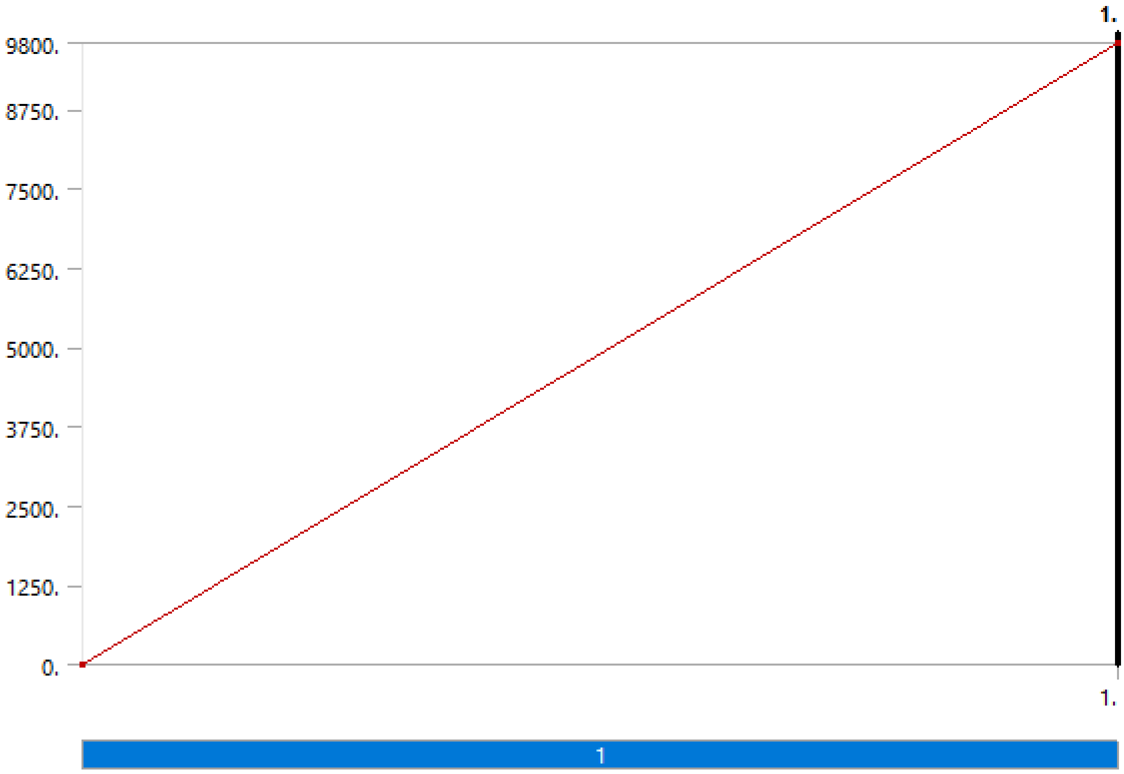

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FIGURE 5
Model (A4) > Static Structural (A5) > Hydrostatic Pressure Sands side

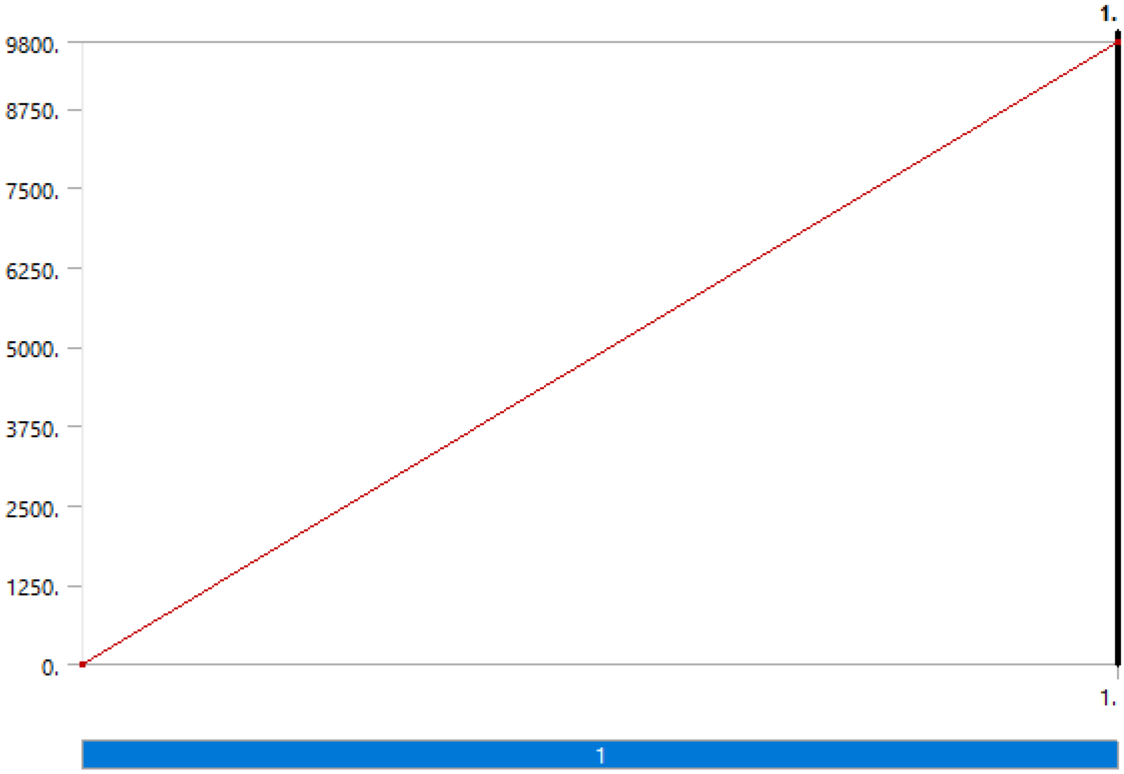

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FIGURE 6
Model (A4) > Static Structural (A5) > Pressure Pedestrian

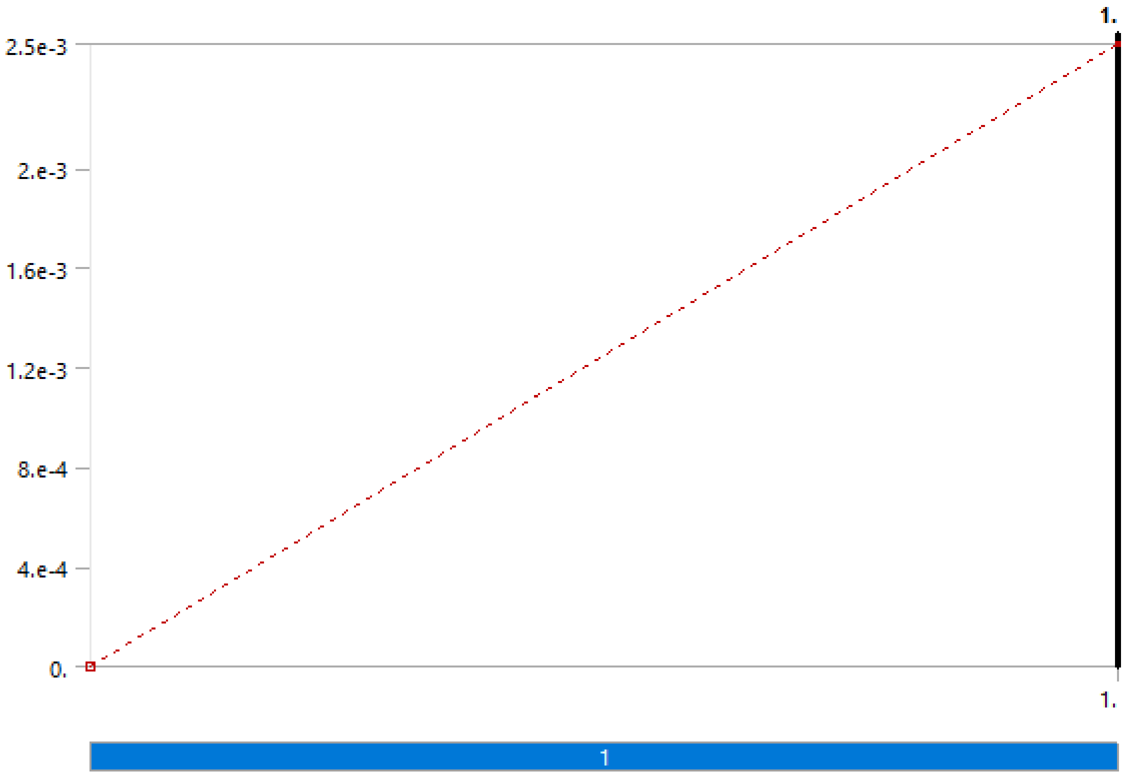

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FIGURE 7
Model (A4) > Static Structural (A5) > Hydrostatic Pressure Sands top

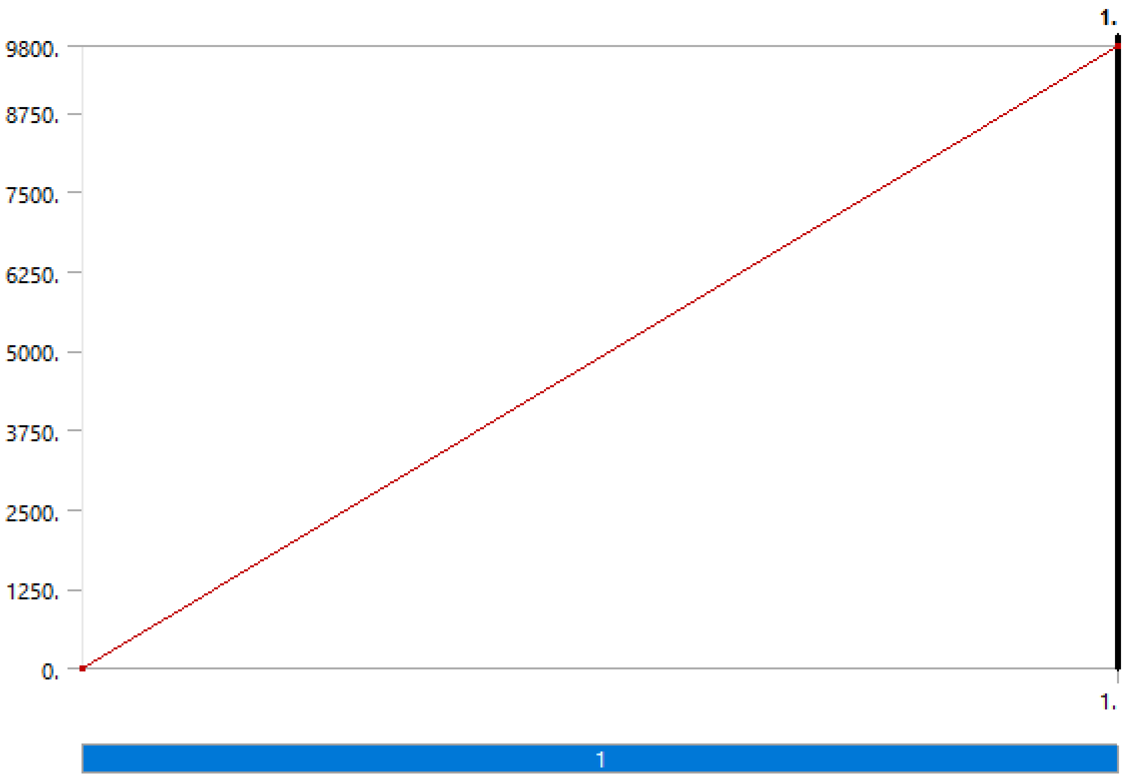

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FIGURE 8
Model (A4) > Static Structural (A5) > Displacement Bottom 2

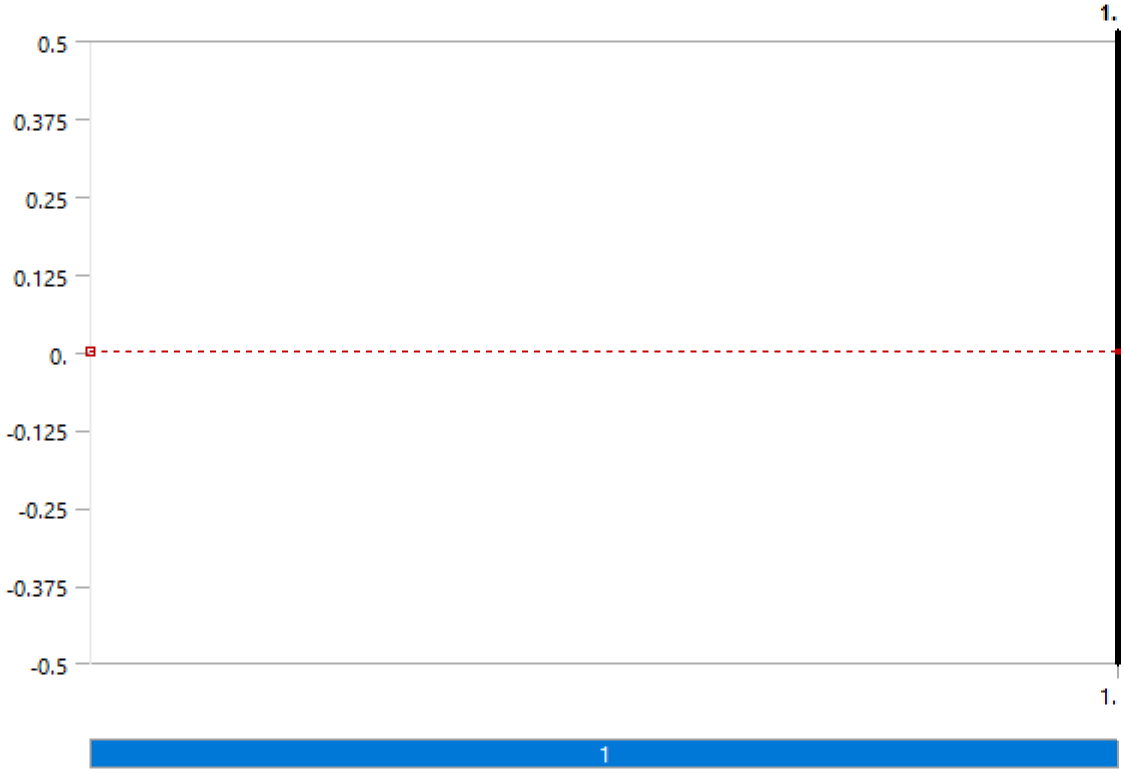

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FIGURE 9
Model (A4) > Static Structural (A5) > Displacement Bottom 3

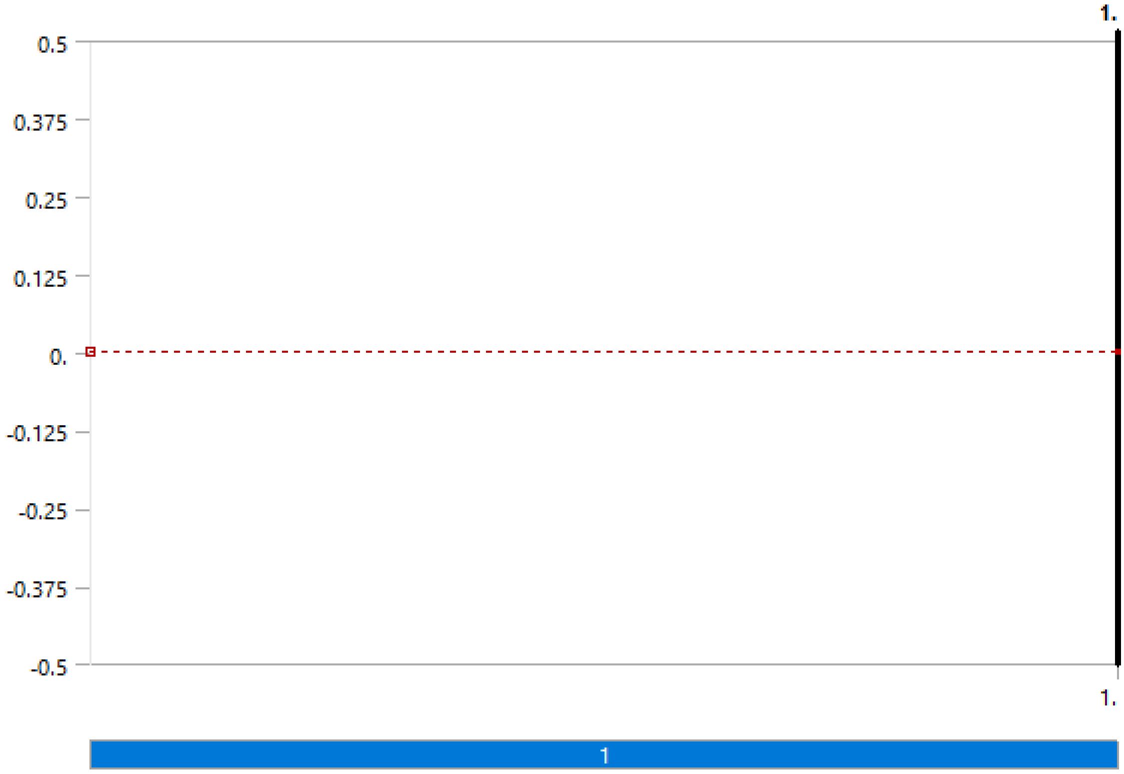

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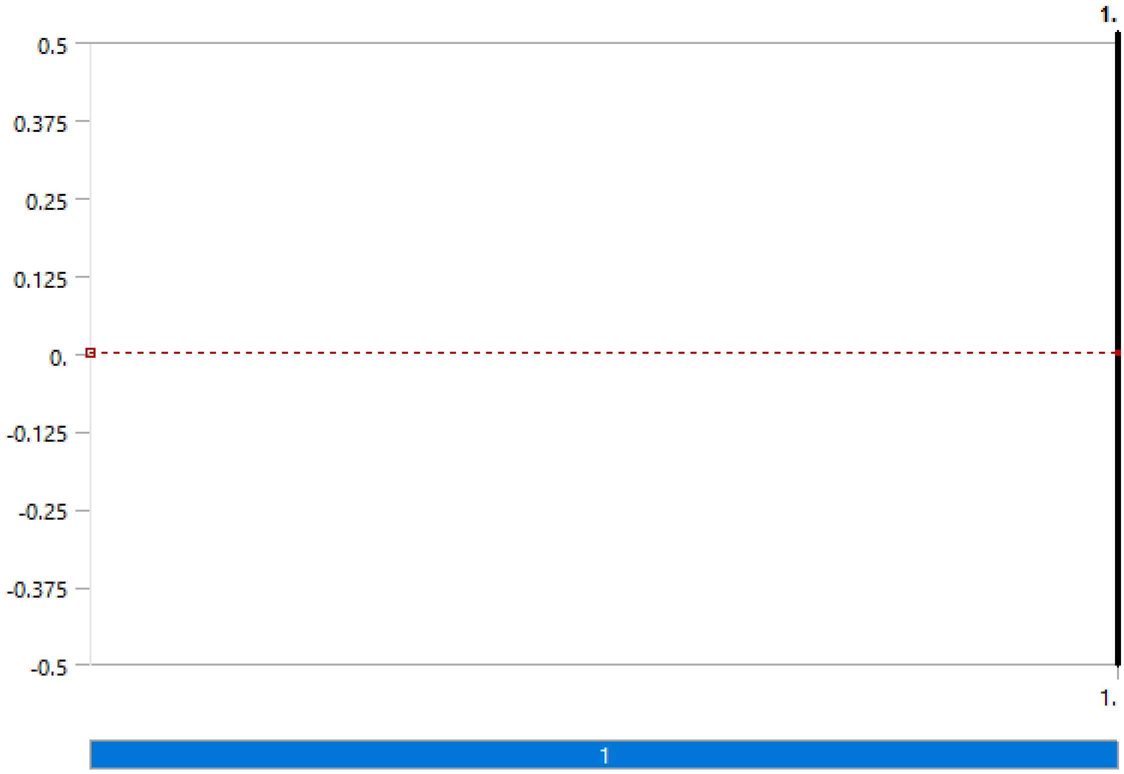
FIGURE 10
Model (A4) > Static Structural (A5) > Displacement Bottom 4



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Solution (A6)

TABLE 12
Model (A4) > Static Structural (A5) > Solution

Object Name	*Solution (A6)*
State	Solved
Adaptive Mesh Refinement	
Max Refinement Loops	1.
Refinement Depth	2.
Information	
Status	Done
MAPDL Elapsed Time	1 m 12 s
MAPDL Memory Used	10.704 GB
MAPDL Result File Size	347.94 MB
Post Processing	
Beam Section Results	No
On Demand Stress/Strain	No

TABLE 13
Model (A4) > Static Structural (A5) > Solution (A6) > Solution Information

Object Name	*Solution Information*
State	Solved
Solution Information	
Solution Output	Solver Output
Newton-Raphson Residuals	0
Identify Element Violations	0
Update Interval	2.5 s
Display Points	All
FE Connection Visibility	
Activate Visibility	Yes
Display	All FE Connectors
Draw Connections Attached To	All Nodes
Line Color	Connection Type
Visible on Results	No
Line Thickness	Single
Display Type	Lines

TABLE 14
Model (A4) > Static Structural (A5) > Solution (A6) > Results

Object Name	*Total Deformation*	*Equivalent Stress*	*Directional Deformation Y*	*Directional Deformation X*	*Directional Deformation Z*
State	Solved				
Scope					
Scoping Method	Geometry Selection				
Geometry	All Bodies				
Position		Top/Bottom			
Definition					
Type	Total Deformation	Equivalent (von-Mises) Stress	Directional Deformation		
By	Time				

Display Time	Last	1. s	Last		
Calculate Time History	Yes				
Identifier					
Suppressed	No				
Orientation			Y Axis	X Axis	Z Axis
Coordinate System			Global Coordinate System		
Results					
Minimum	0.37046 mm	2.459e-002 MPa	-12.952 mm	-102.27 mm	-133.08 mm
Maximum	187.13 mm	47.216 MPa	120.26 mm	122.27 mm	92.03 mm
Average	77.507 mm	3.12 MPa	60.193 mm	-2.7183 mm	-6.3439 mm
Minimum Occurs On	TorusII_simplified@Fillet314				
Maximum Occurs On	TorusII_simplified@Fillet314				
Information					
Time	1. s				
Load Step	1				
Substep	1				
Iteration Number	1				
Integration Point Results					
Display Option		Averaged			
Average Across Bodies		No			

FIGURE 11
Model (A4) > Static Structural (A5) > Solution (A6) > Total Deformation

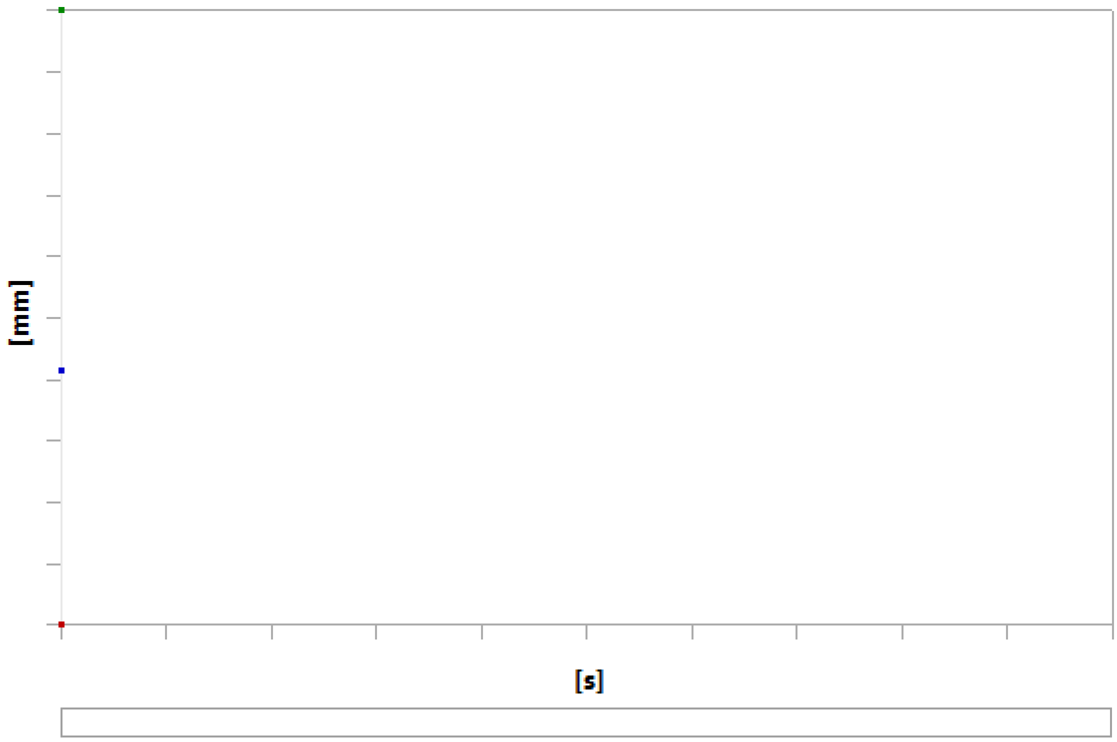

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TABLE 15
Model (A4) > Static Structural (A5) > Solution (A6) > Total Deformation

Time [s]	Minimum [mm]	Maximum [mm]	Average [mm]
1.	0.37046	187.13	77.507

FIGURE 12
Model (A4) > Static Structural (A5) > Solution (A6) > Equivalent Stress

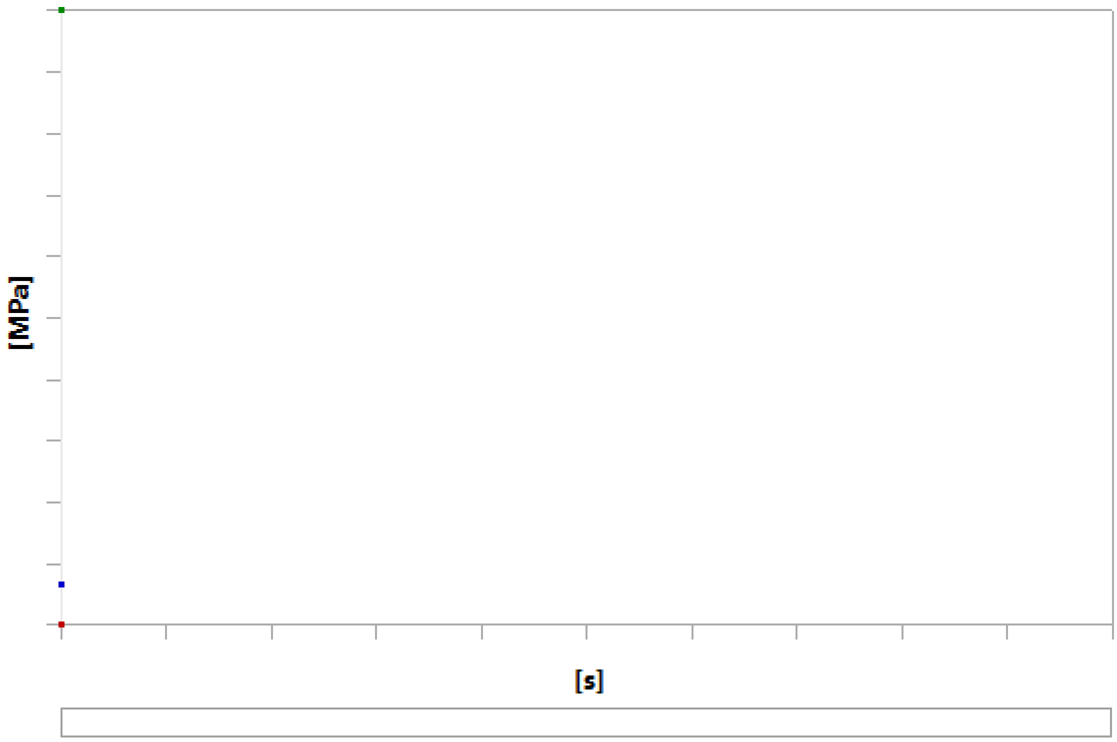

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TABLE 16
Model (A4) > Static Structural (A5) > Solution (A6) > Equivalent Stress

Time [s]	Minimum [MPa]	Maximum [MPa]	Average [MPa]
1.	2.459e-002	47.216	3.12

FIGURE 13
Model (A4) > Static Structural (A5) > Solution (A6) > Directional Deformation Y

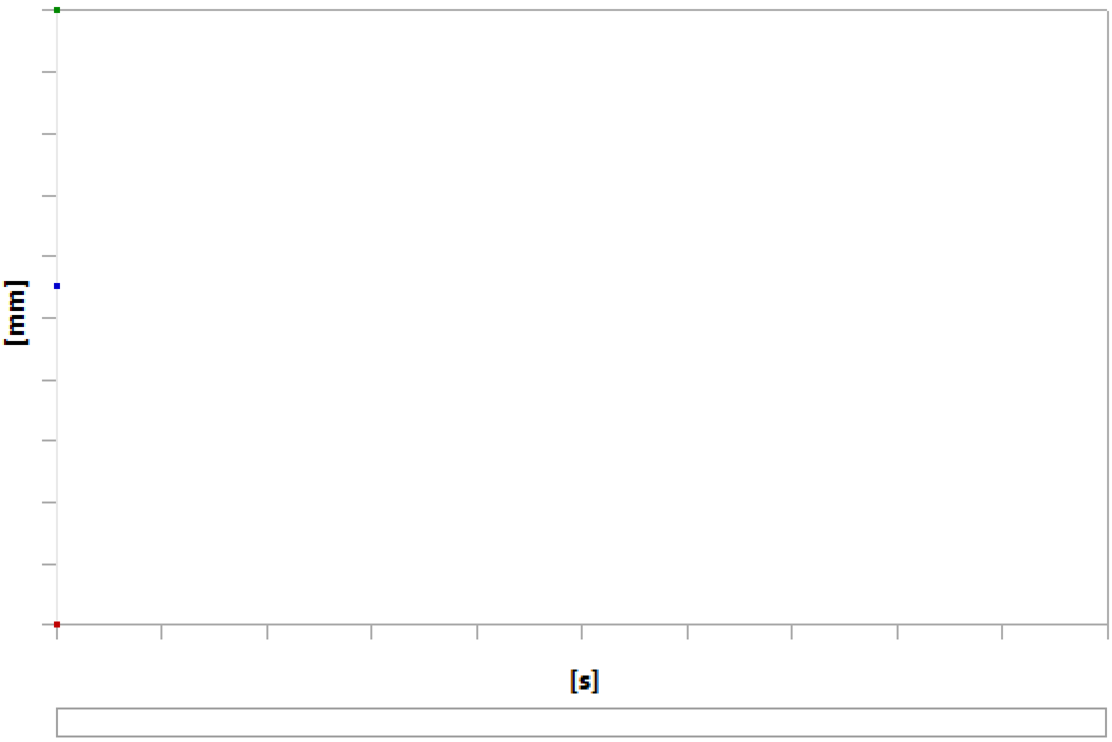

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TABLE 17
Model (A4) > Static Structural (A5) > Solution (A6) > Directional Deformation Y

Time [s]	Minimum [mm]	Maximum [mm]	Average [mm]
1.	-12.952	120.26	60.193

FIGURE 14
Model (A4) > Static Structural (A5) > Solution (A6) > Directional Deformation X

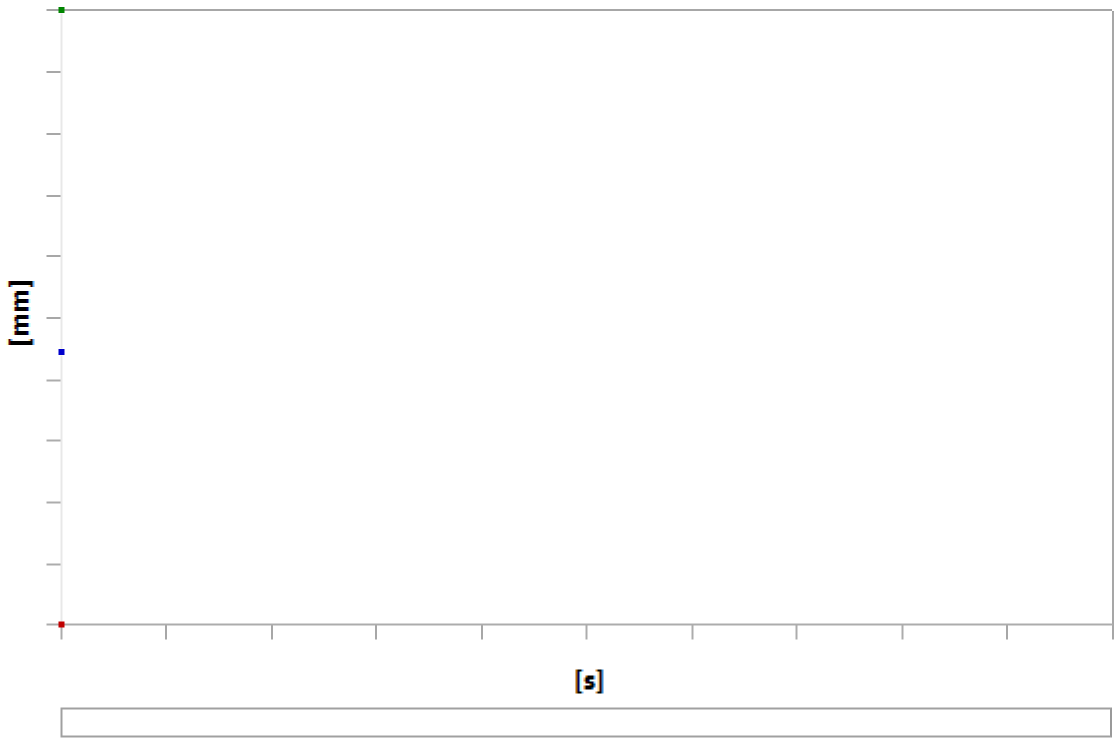

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TABLE 18
Model (A4) > Static Structural (A5) > Solution (A6) > Directional Deformation X

Time [s]	Minimum [mm]	Maximum [mm]	Average [mm]
1.	-102.27	122.27	-2.7183

FIGURE 15
Model (A4) > Static Structural (A5) > Solution (A6) > Directional Deformation Z

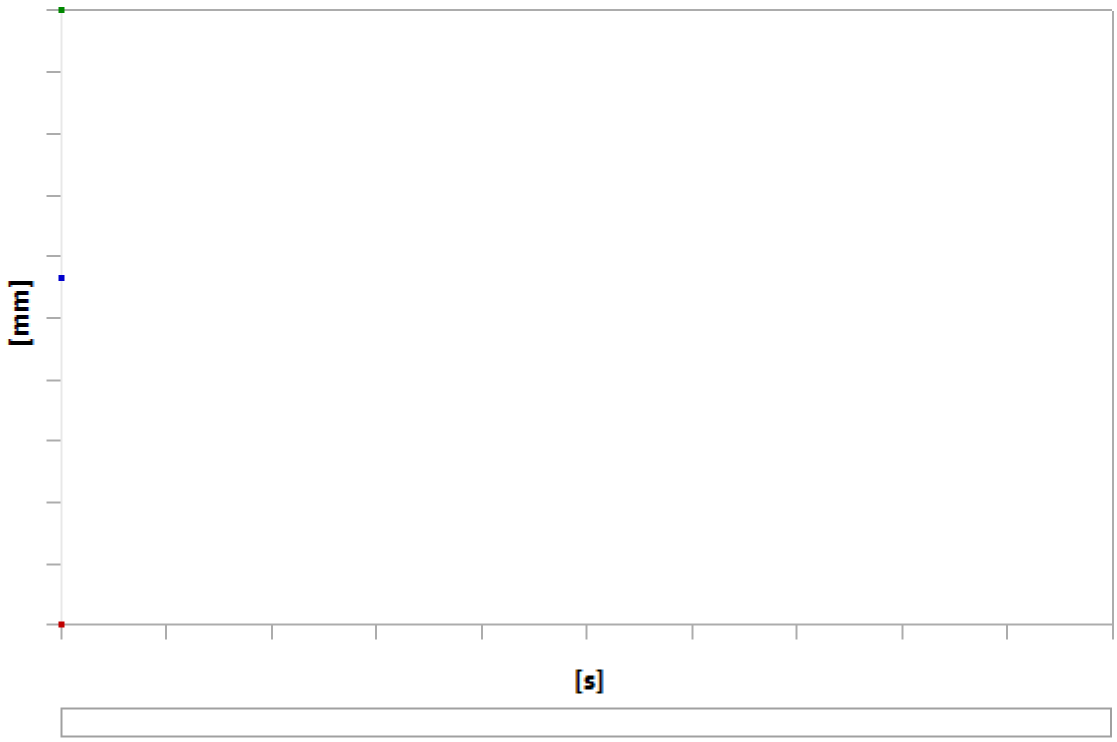

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TABLE 19
Model (A4) > Static Structural (A5) > Solution (A6) > Directional Deformation Z

Time [s]	Minimum [mm]	Maximum [mm]	Average [mm]
1.	-133.08	92.03	-6.3439

Material Data

Polyethylene

TABLE 20
Polyethylene > Constants

Density	9.4e-007 kg mm^-3
Coefficient of Thermal Expansion	2.3e-004 C^-1
Specific Heat	2.3e+006 mJ kg^-1 C^-1
Thermal Conductivity	2.8e-004 W mm^-1 C^-1

TABLE 21
Polyethylene > Color

Red	Green	Blue
130	154	176

TABLE 22
Polyethylene > Compressive Ultimate Strength

Compressive Ultimate Strength MPa
0

TABLE 23
Polyethylene > Compressive Yield Strength

Compressive Yield Strength MPa
0

TABLE 24
Polyethylene > Tensile Yield Strength

Tensile Yield Strength MPa
25

TABLE 25
Polyethylene > Tensile Ultimate Strength

Tensile Ultimate Strength MPa
33

TABLE 26
Polyethylene > Isotropic Secant Coefficient of Thermal Expansion

Zero-Thermal-Strain Reference Temperature C
22

TABLE 27
Polyethylene > Isotropic Elasticity

Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa	Temperature C
240	0.45	800	82.759	