Declaration of Conformity

REPORT NUMBER:
R1-297504

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Order no.: 297504
Rev.: R1
Appendices: 1

Assignor:	Uponor Infra AB Industrivägen 11 SE-51332
Subject:	Review and declaration of conformity of FEM-calculations for Septic Tank 1m³.
Documentation:	The assignor has sent calculations for review on 2025-01-21 and final calculation report on 2025-01-29. Document name: “Septic Tank 1m3”.
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 draft calculation was reviewed between the 2025-01-22 and 2025-01-24 and comments were sent to the client. The final report was revised according to some comments, and other parts were more thoroughly described.
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:	2025-01-31, 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 Specialist	Ulrik Hindsberger Centre Project Manager

DIGITALLY SIGNED DOCUMENT
31 January 2025
DANISH TECHNOLOGICAL INSTITUTE

ilac-MRA

DANAK
Test Reg. No. 2
CPR NB 1235

DANISH TECHNOLOGICAL INSTITUTE

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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

Septic Tank 1m3

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 Septic Tank 1m3, 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 Septic Tank 1m3, 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 surface model. This model is part of the surface model which is fully developed for the tooling of roto-mould. The overall wall thickness is 8.5mm. Minus variation of the wall thickness is not considered in this calculation.

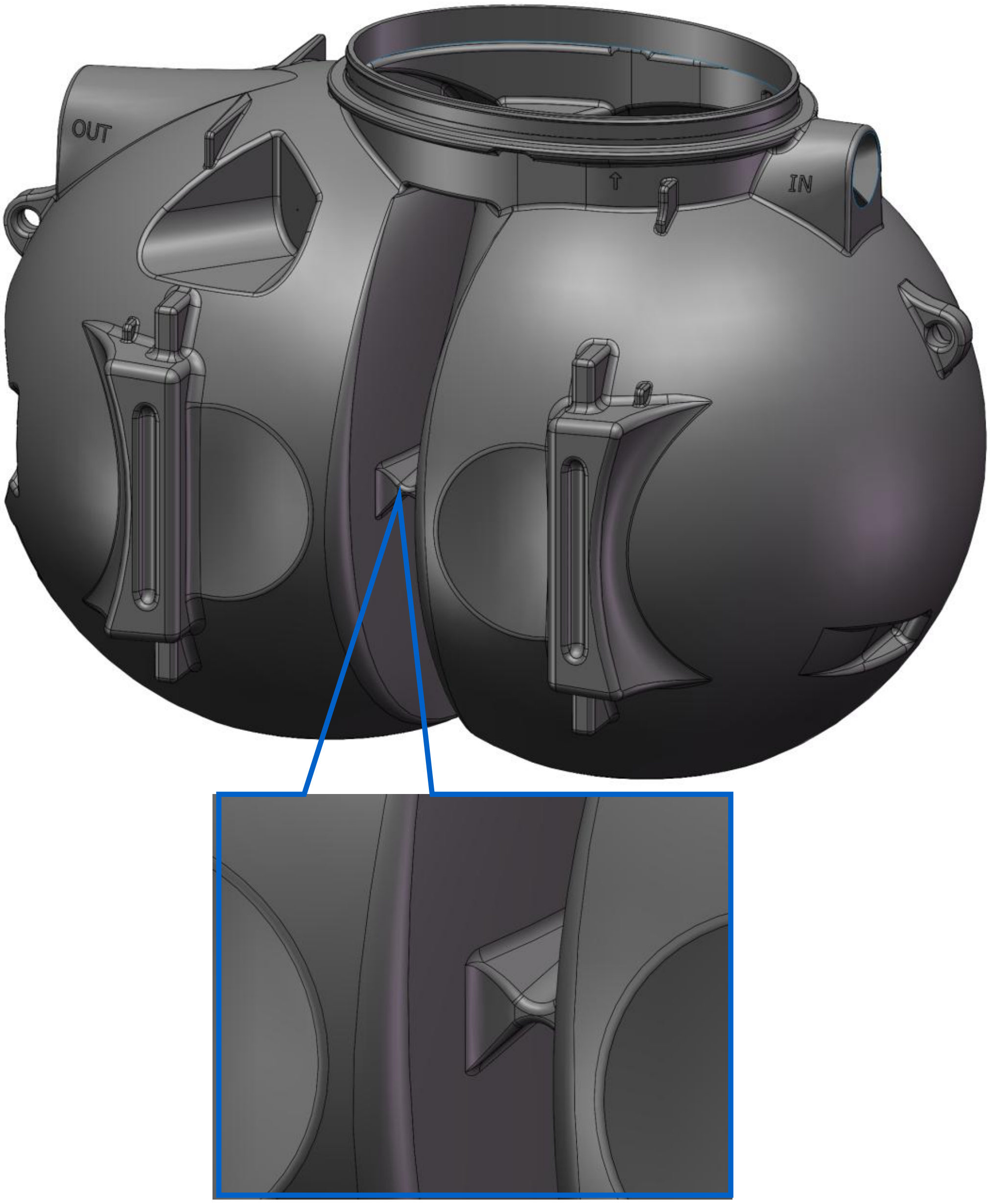


Figure 1: original surface model

The 3D model for analysis (Figure 2) 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.

The middle ribs (include the kiss-off features) are replaced by simple ribs, as they make the mesh model too complex. The shape change won't have big impact on the overall result, and these areas will be filled by sands which will reinforce the structure.

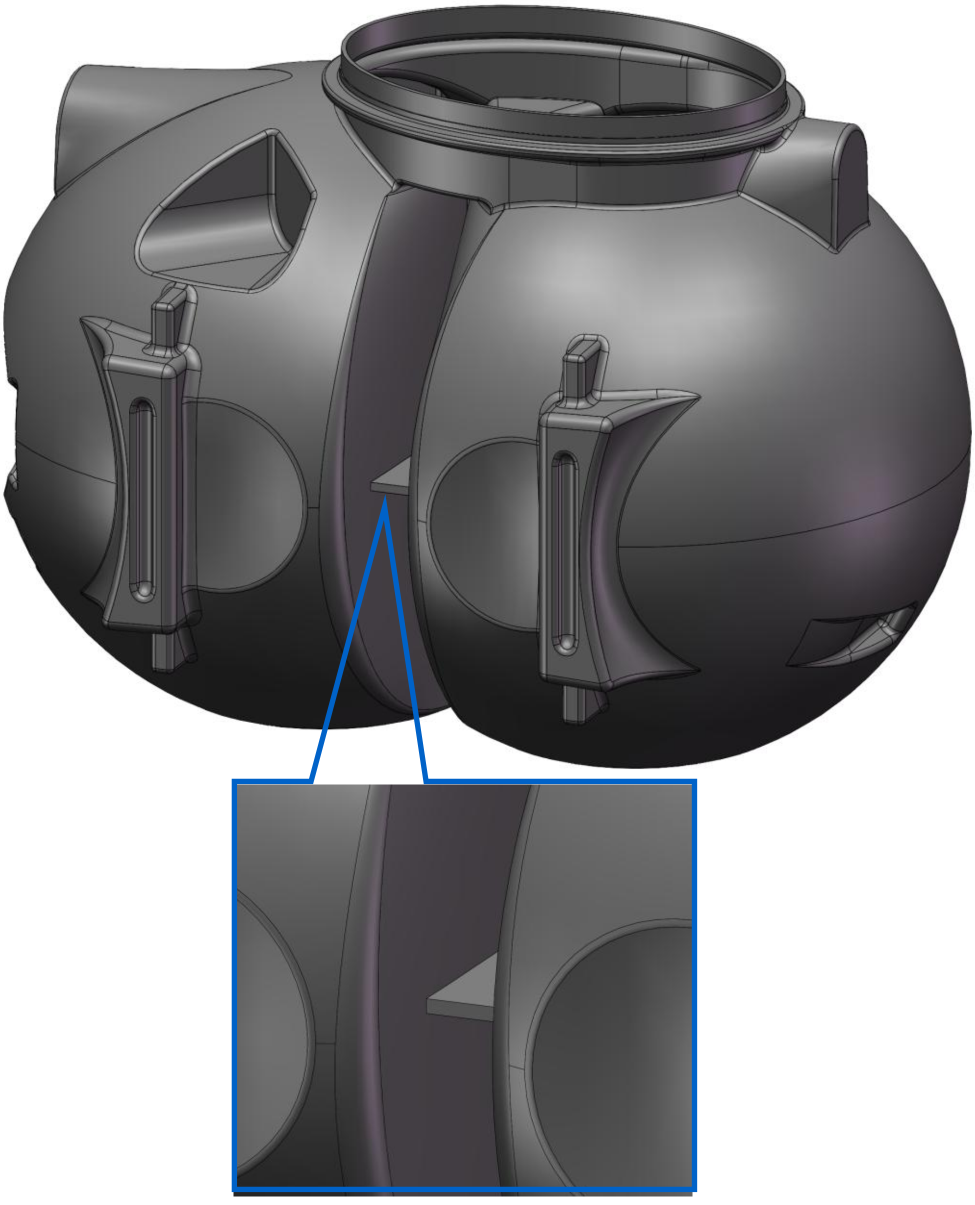


Figure 2: simplified model for analysis

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	$\boxed{750}$	$\boxed{\text{MPa}}$	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	$\boxed{730}$

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

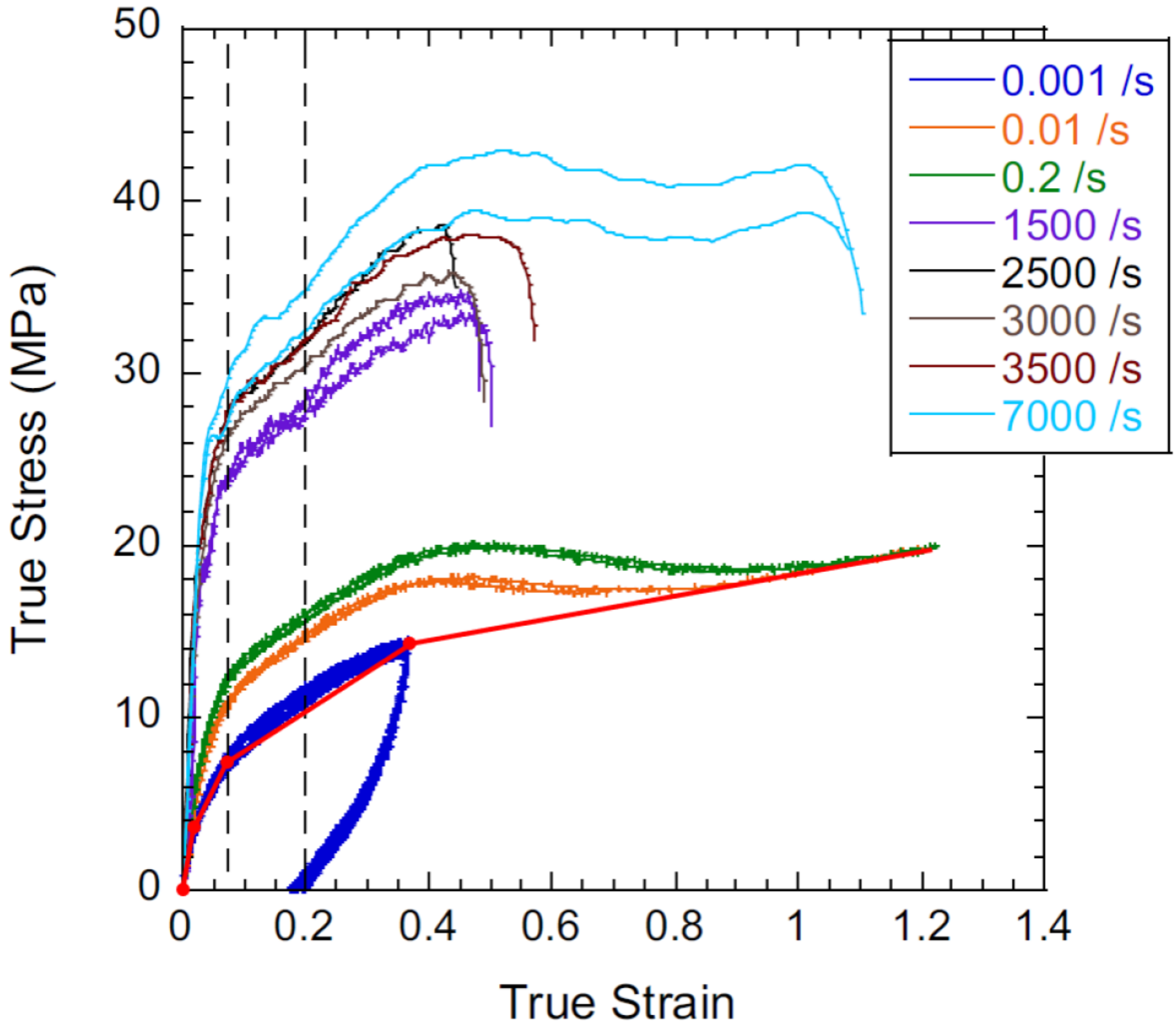


Figure 3: Stress-Strain curve

2.3. Mesh

Solid (shell) model is used as the geometry for analysis. Wall thickness is 8.5mm per the design intend.

The mesh is using linear shell elements. Element size set to 10mm. Per the preliminary simulation, surfaces where the max stress located are refined with a refinement factor of 1.

Total nodes are 1,186,563 and elements are 624,769 accordingly. (Figure 4)

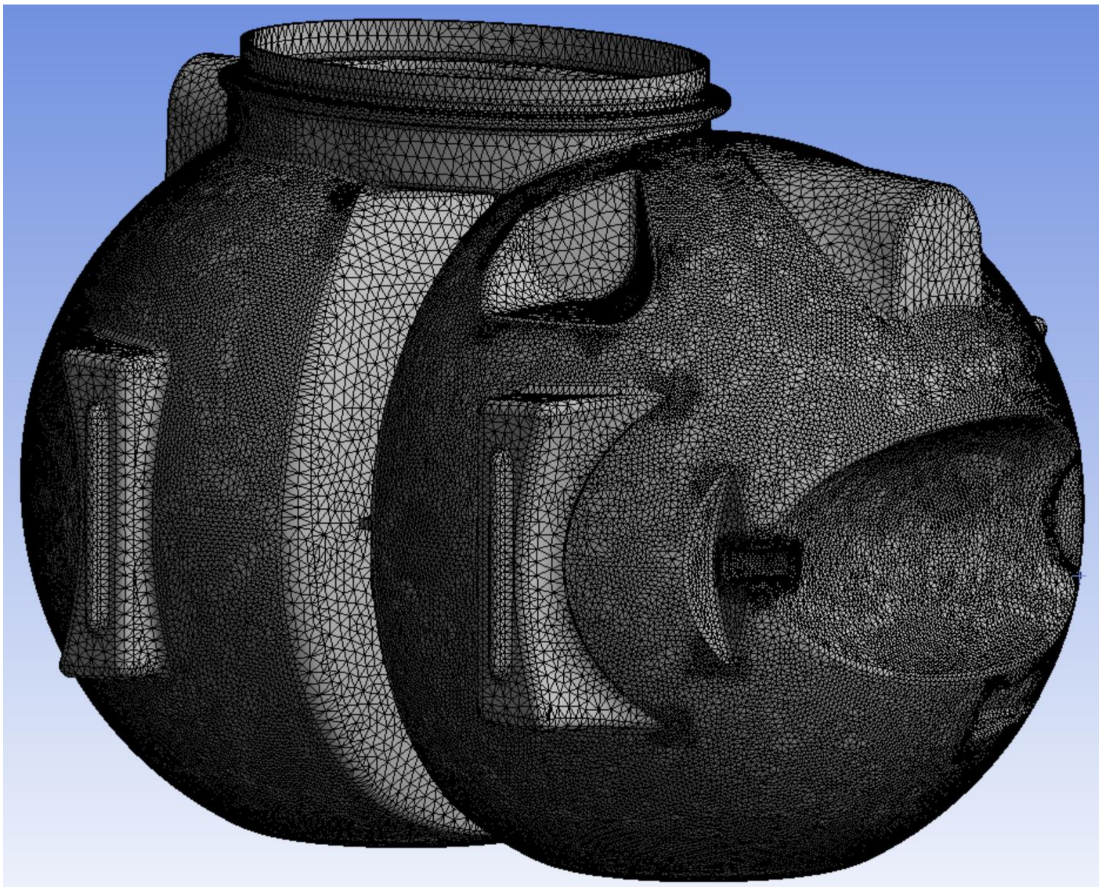


Figure 4: mesh elements

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 point at bottom centre area 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 riser as the XZ displacement constrains. The riser components are 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.

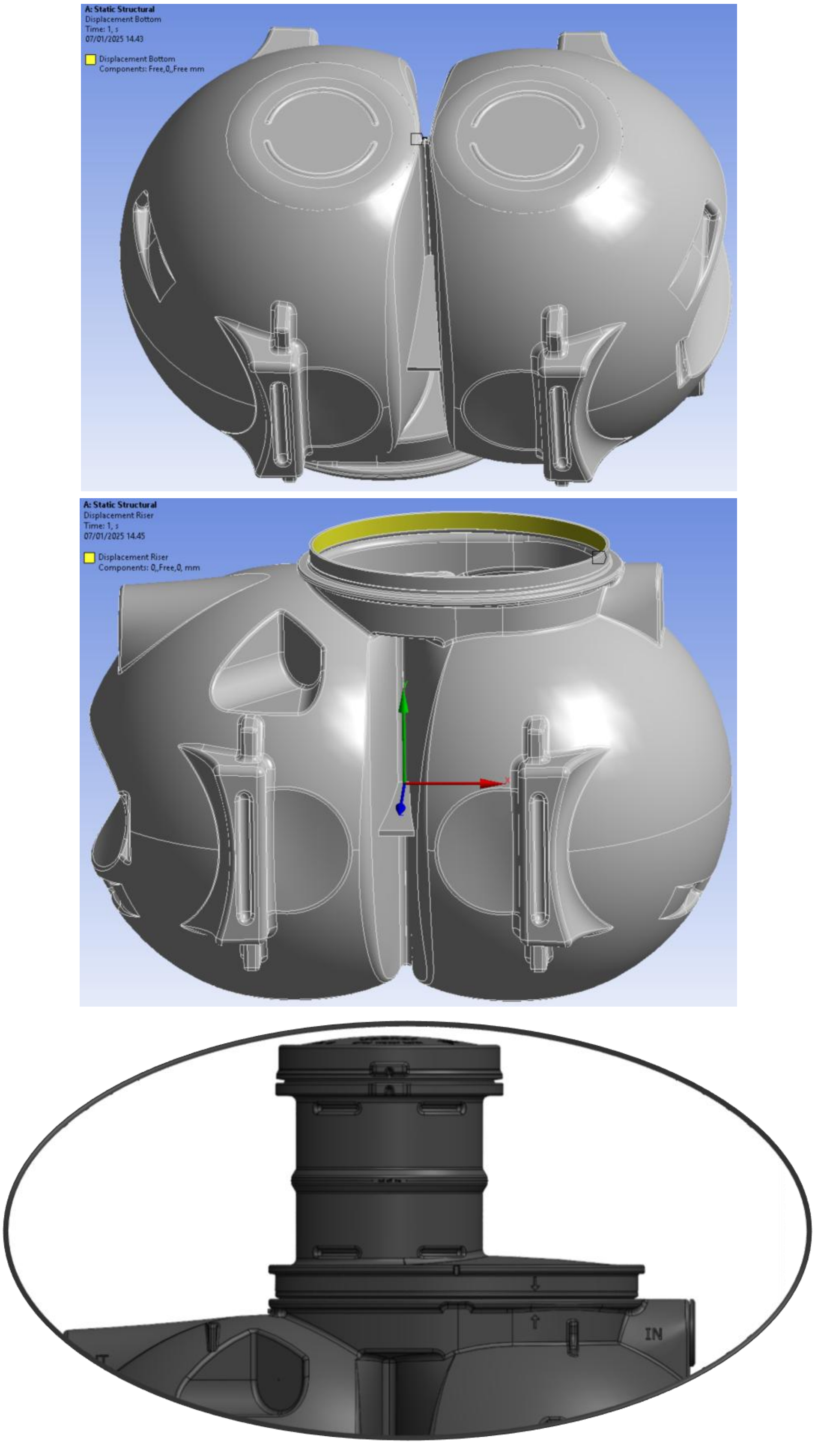


Figure 5: Boundary conditions

The internal 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 concaved spaces (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.

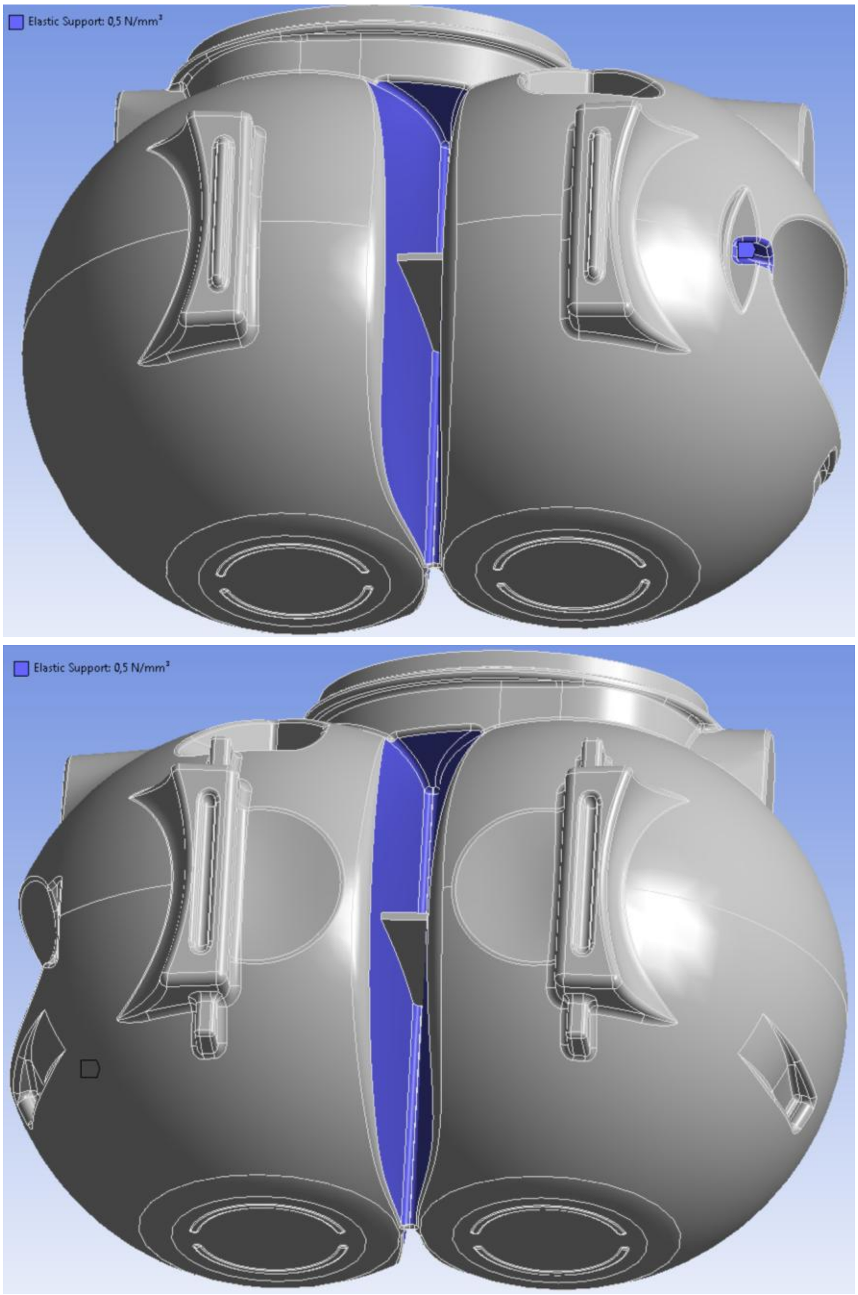


Figure 6: Elastic support

2.5. Loads

According to EN 12566-1:2016 5.1.2, the load conditions are shown in Figure 7. Only worst-case load combination is calculated, suppose that results of all other load combinations are “pass” if result of worst-case load combination is “pass”.
Gravity load is also applied. Density is set to 940Kg/m3.
Even though most of the time water is filled inside the tank, the internal hydrostatic load is not applied.

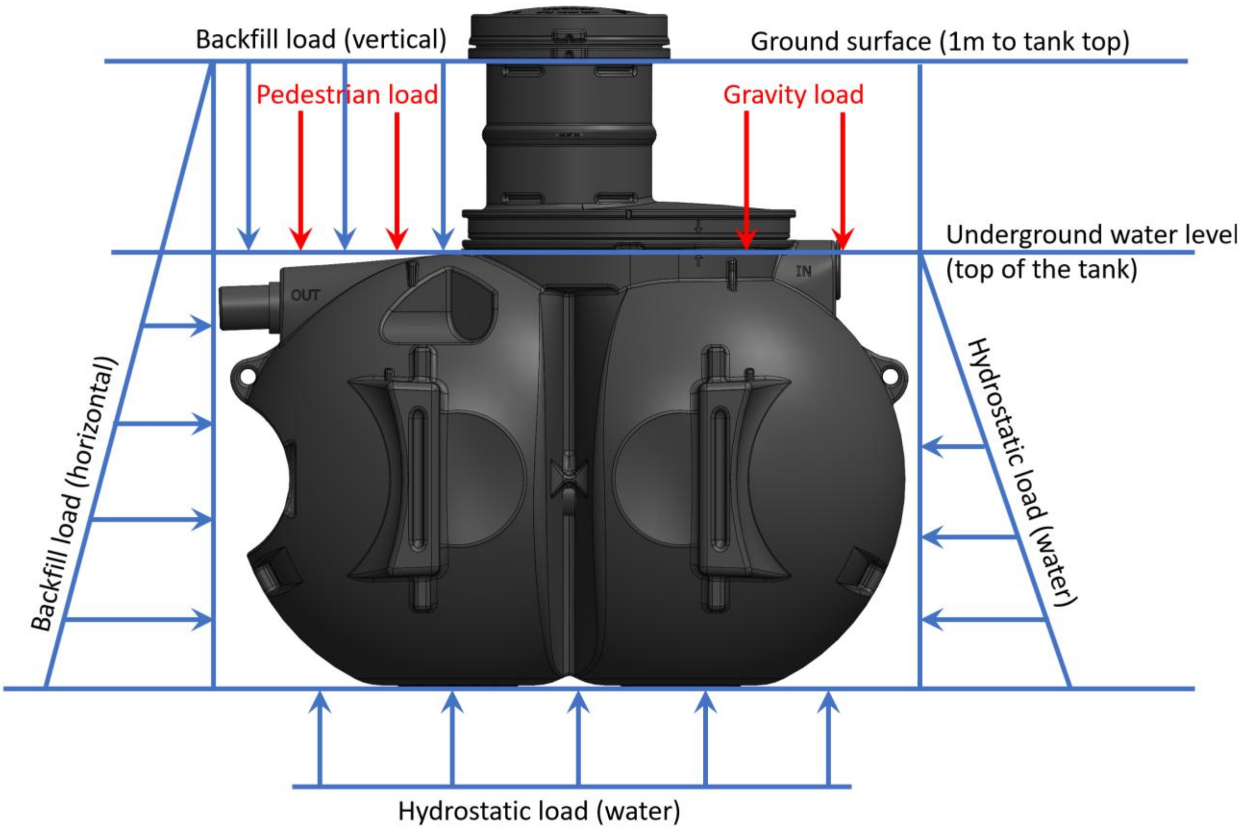


Figure 7: Loads

- 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). Two relatively larger low risk areas (green surfaces in Figure 9), and several small risk areas which are so small that can be ignored. High risk areas are located at the small, concaved corners (red surfaces in Figure 10). High risk area is very small and local, and considered to be ignored.

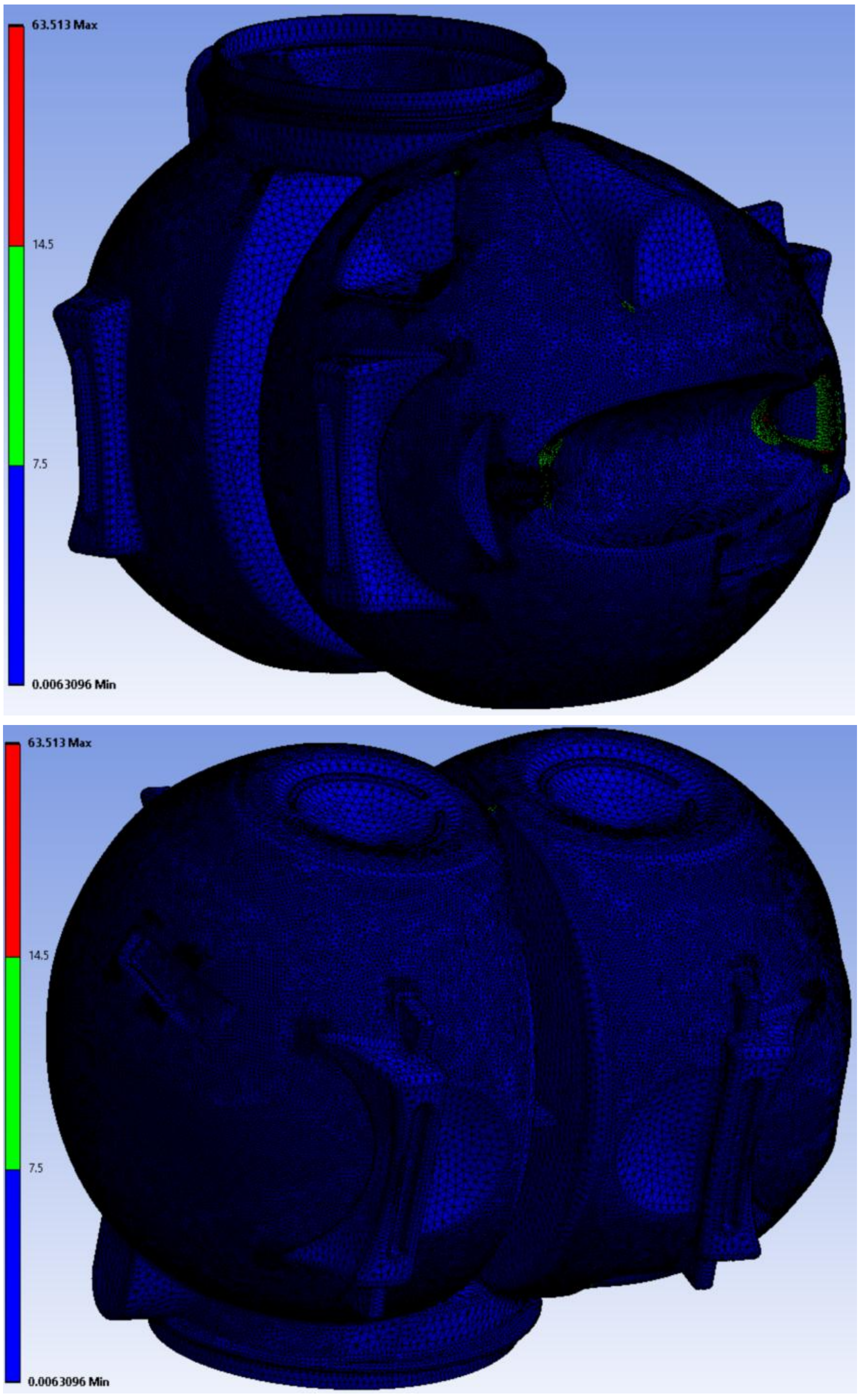


Figure 8: Equivalent stress overview

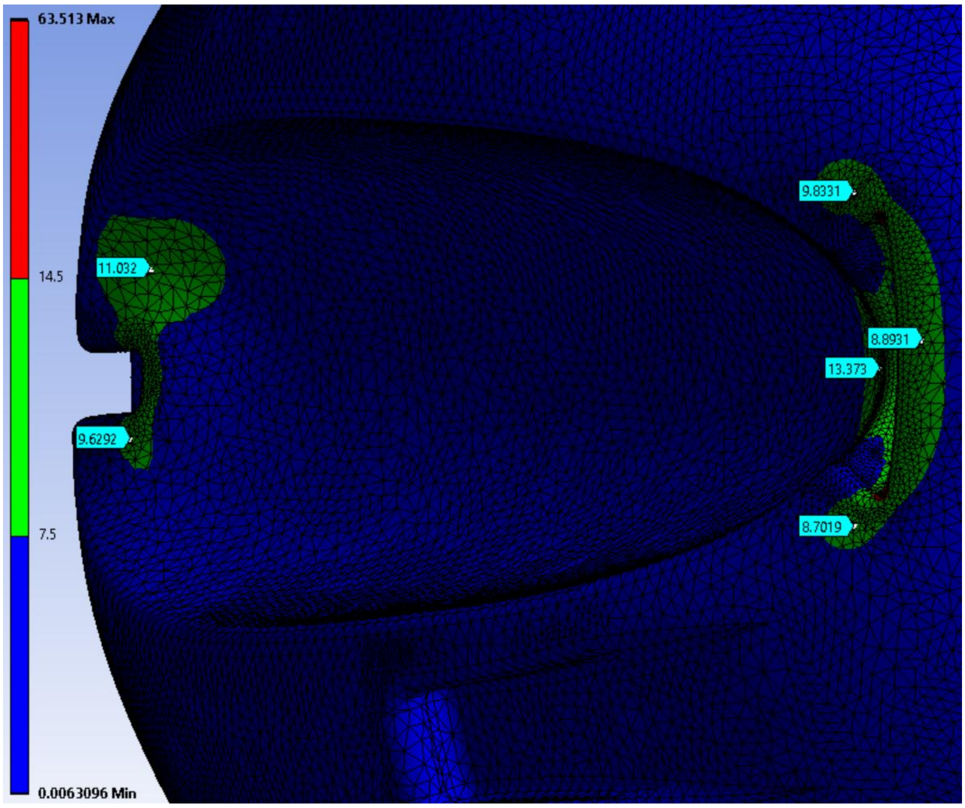


Figure 9: Low risk area

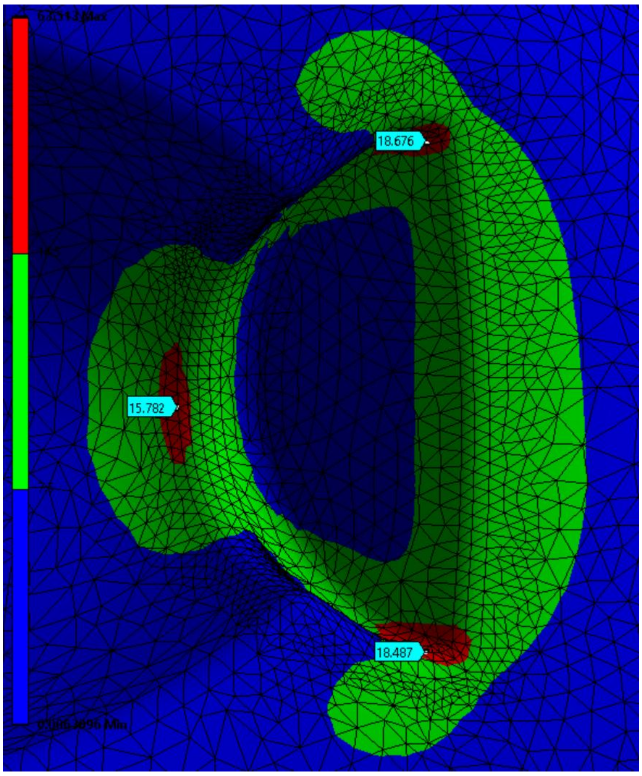


Figure 10: High risk area

3.2. Deformation

Total deformation overview is shown in Figure 11. Simulation shows the majority of the area has a deformation less than 20mm. Max deformation area is on the side concaved surface with a max deformation of 44mm.

According to the result, even take the maximum deformation into account, the average decrease in X direction should be less than 50mm (refer to Figure 12). The average decrease in Z direction should be less than 20mm (refer to Figure 14). The average decrease in height (Y direction) should be less than 20mm (refer to Figure 13). Treat the tank as a box with XYZ dimension of 1650x1080x1100mm, the rough calculation of total volume lose is around 7%.

Figure 15 shows the displacement of the inlet and outlet area. Both areas are not tweaked. Displacement of inlet centre is 7mm and the displacement of outlet centre is 20mm. With a 1m pipe, the tilt angle caused is around 0.4° and 1.2°. This kind of displacement won't cause leakage.

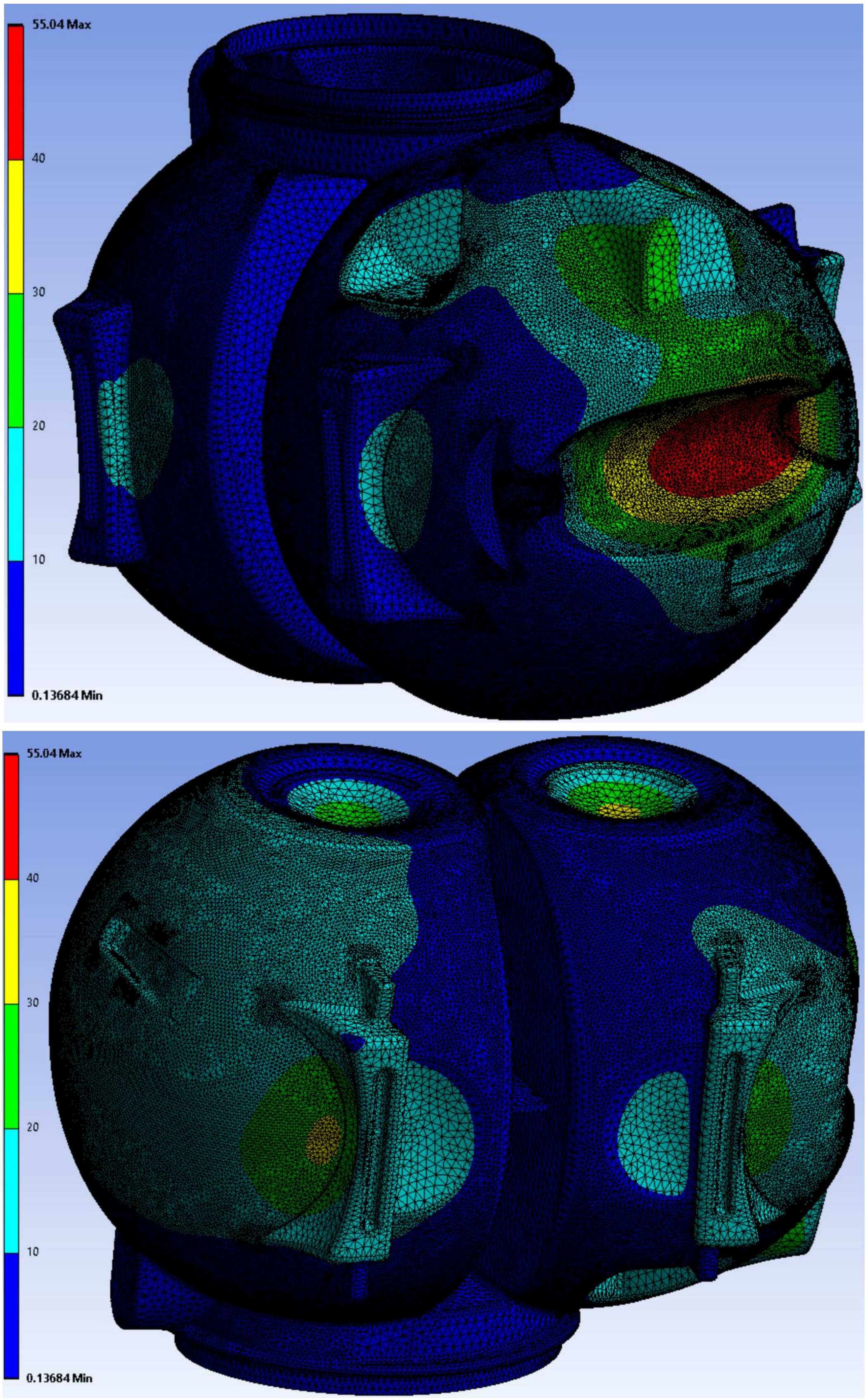
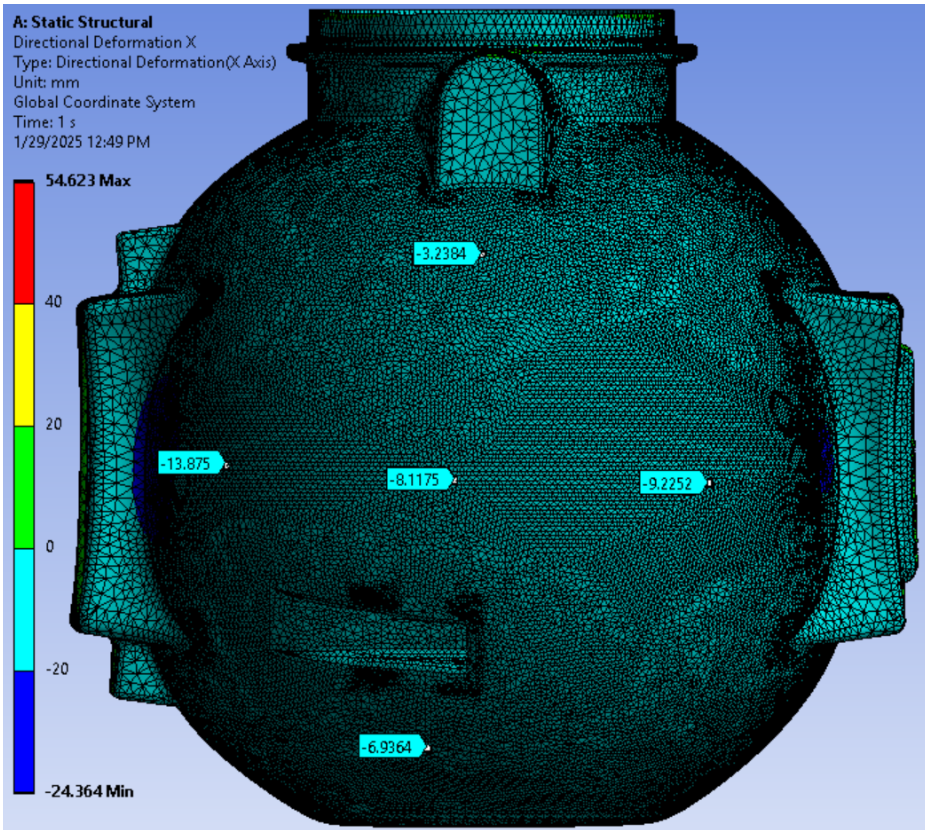


Figure 11: Total deformation



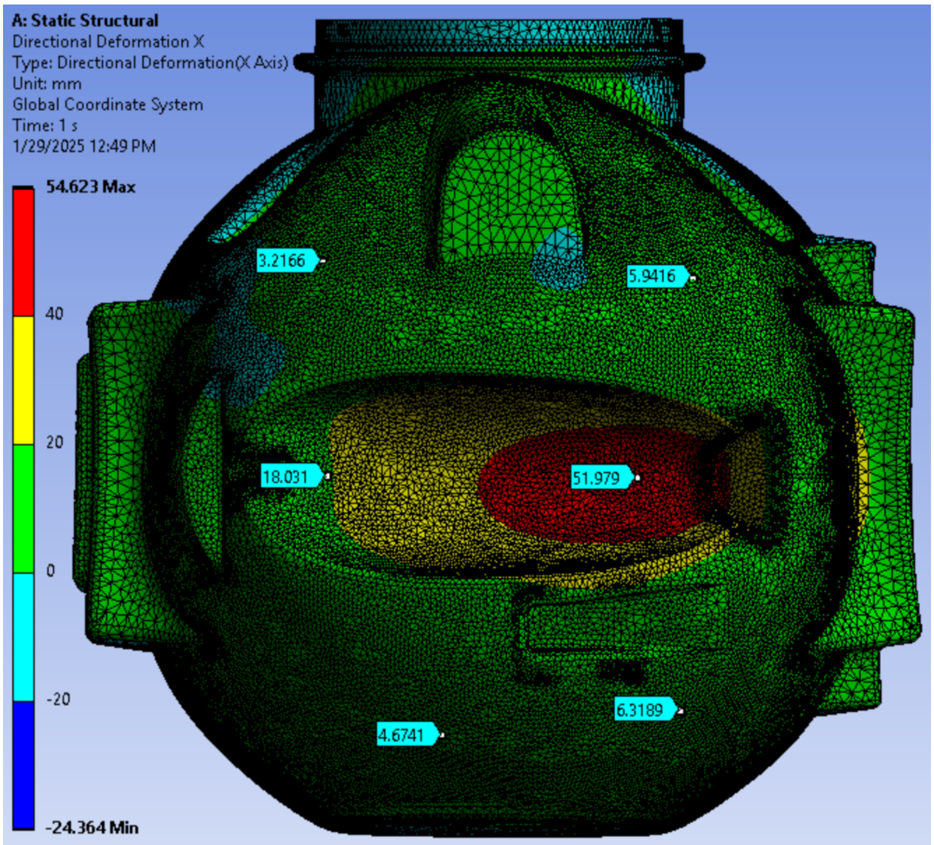


Figure 12: Deformation in X direction

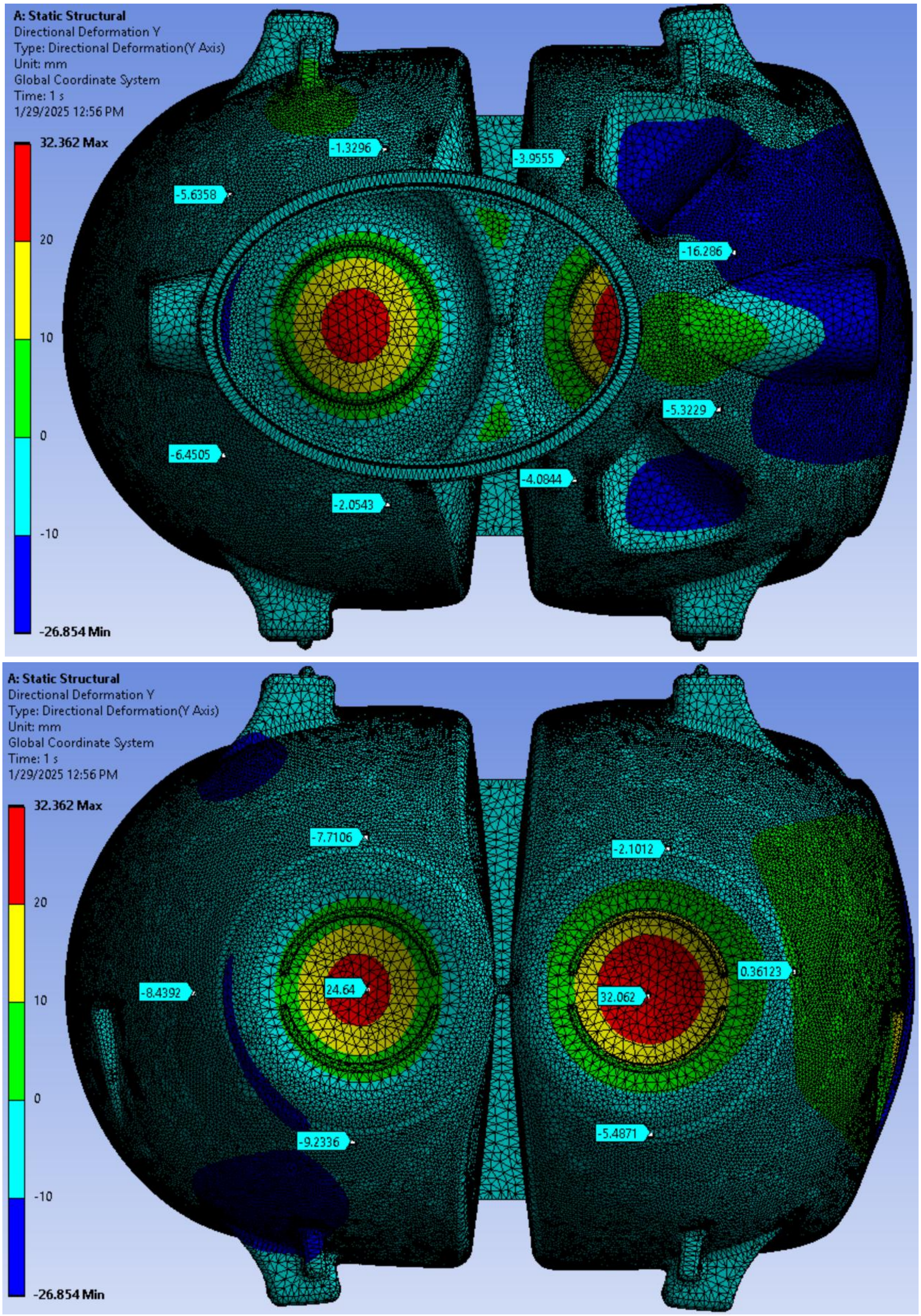


Figure 13: Deformation in Y direction

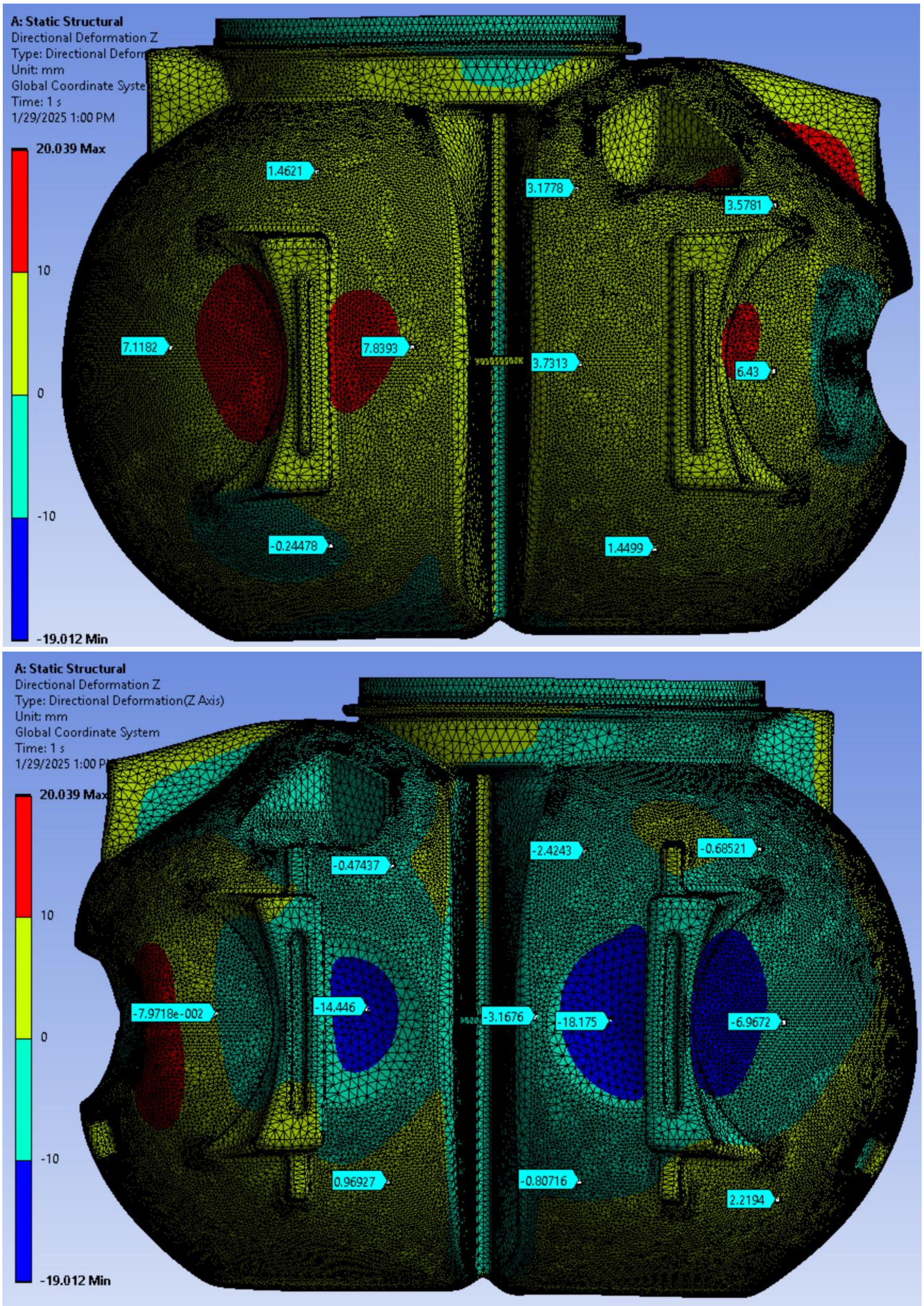


Figure 14: Deformation in Z direction

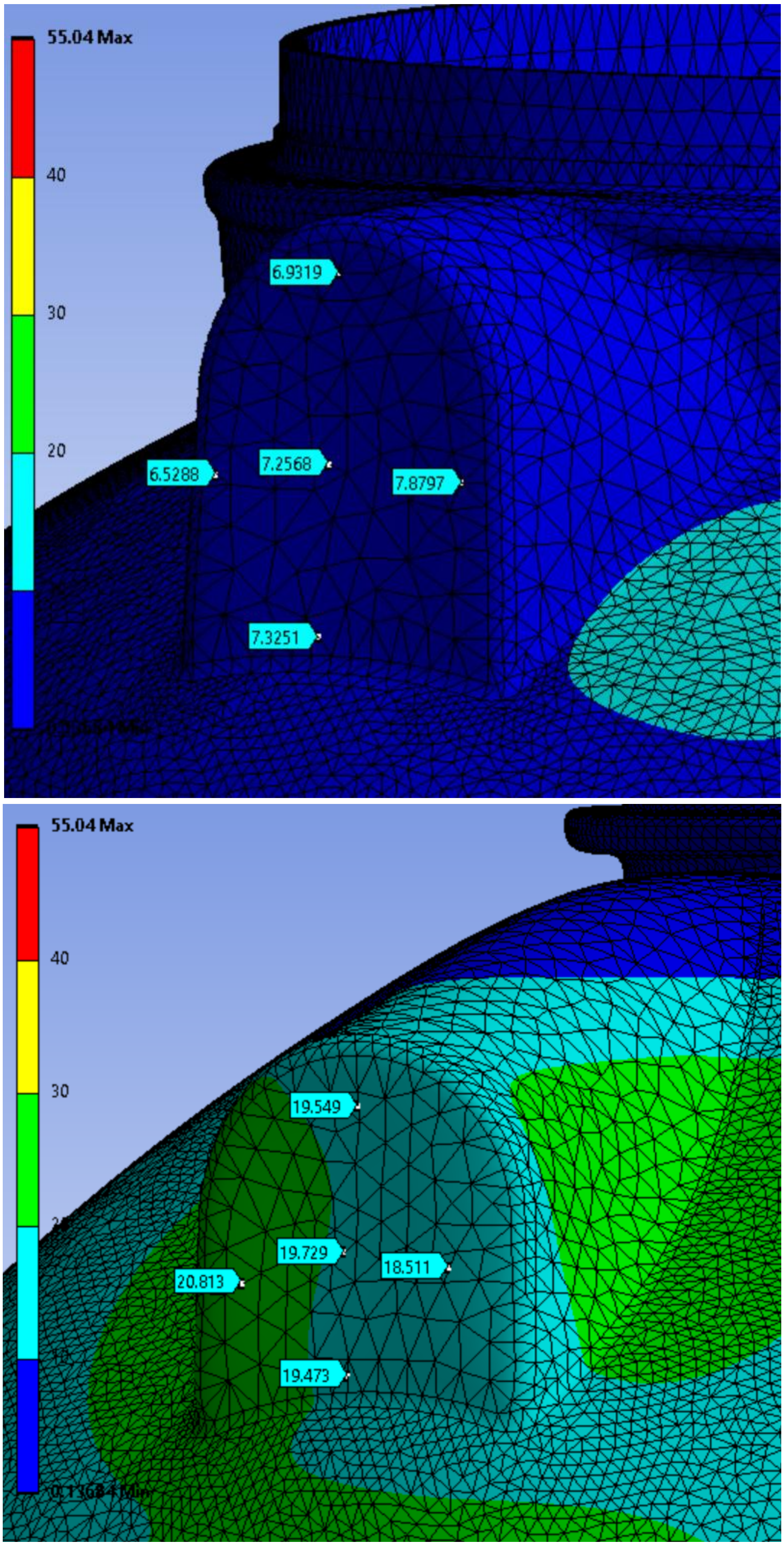


Figure 15: Deformation at inlet and outlet area

4. Conclusions

According to the standard of EN 12566-1:2016 D.6.3, for septic 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
0,1	Draft version for review.	08/01/2025
1,0	Released for approval.	21/01/2025
2,0	Update for Declaration of Conformity.	28/01/2025

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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uponor

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