Strength assessment of optic access chamber

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1 SUMMARY

1.1 Executive summary

Ultimate Strength analysis was conducted for the optic access chamber made of polyethylene. The distributed load was applied on the hatch cover of access chamber and increased up to total collapse.

The total ultimate load before the collapse of the access chamber was approximately 11 kN which corresponds to 1121 kg of weight. However, this result can be considered as conservative as the supporting effect of the soil to the sides of the access chamber is not considered. In installed condition the access chamber is located in 0.5 m below the surface. Therefore, it can be assumed that the chamber has to carry also partly the weight of the soil located vertically on top of the hatch. By taking into account the approximated the weight of the soil as 480 kg the access chamber can carry at least 640 kg of weight. However, it must be noticed that the assumptions made are very conservative and in real installed condition the particular structure can carry more load as 640 kg.

1.2 Revision history

Rev. 02 was issued for comments by company.

2 INTRODUCTION

2.1 Objectives and scope

The aim of the analysis is to determine the maximum load carrying capacity of the optic access chamber made of polyethylene. The loading is applied as distributed load on the hatch cover of access chamber. In installed condition the optic access chamber is surrounded with soil. However, in this analysis the supporting effect of soil is not considered. Thus the current approach for determination of load carrying capacity can be considered as conservative.

2.2 Analyses Approaches

Ultimate strength analysis is carried out with non-linear FE method. The analysis include nonlinear material model for polyethylene, large deflections and contact definitions between the hatch cover and access chamber and between the hatch cover and ground. In order to determine the ultimate strength the distributed load applied on the hatch cover is increased up to the collapse of the access chamber.

3 LOADING

A single load case is defined for optic access chamber. The load is applied to hatch cover as distributed load in the negative z-direction. The load is increased in time so that in two seconds of integration time the distributed load value on hatch cover surface will be equal to 0.03 MPa. The total load in z-direction in that case will reach up to 17.7 kN.

4 MODELLING

4.1 Co-ordinate system

The origin of the co-ordinate system used in FE-model is located in the middle of the bottom plate of the access chamber. The x-axis and y-axis are located in the same surface with the bottom plate of the access chamber.

4.2 Material properties

For material following elastic material properties were used

- Young's Modulus of elasticity $E = 700\ MPa$ and
- Poisson's ratio $\nu = 0.3$.

The nonlinear behavior of the material is defined as elastic ideally plastic. This means that up to yield stress 20 MPa the material behaves elastically and after reaching the yield the material behaves as ideally plastic, see Figure 4-1.

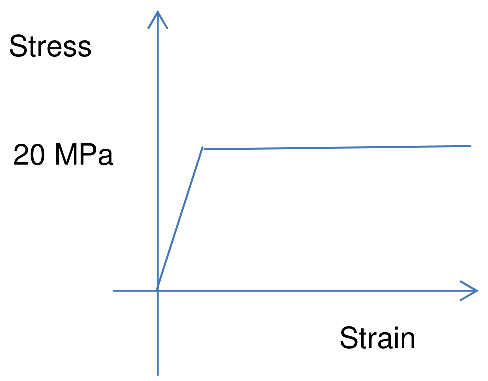


Figure 4-1. Assumed stress strain curve for polyethylene.

4.3 Extent of Model & Mesh Properties

The finite element method based calculation model consists of access chamber and hatch cover. In order to support the structure vertically the rigid surface is added. For modeling there are used four node shell elements. The model consists of 29170 shell elements and 29474 nodes. Element size used in hatch cover and access chamber is approximately 10x10 mm. For better understanding of FE-model see Figure 4-2.

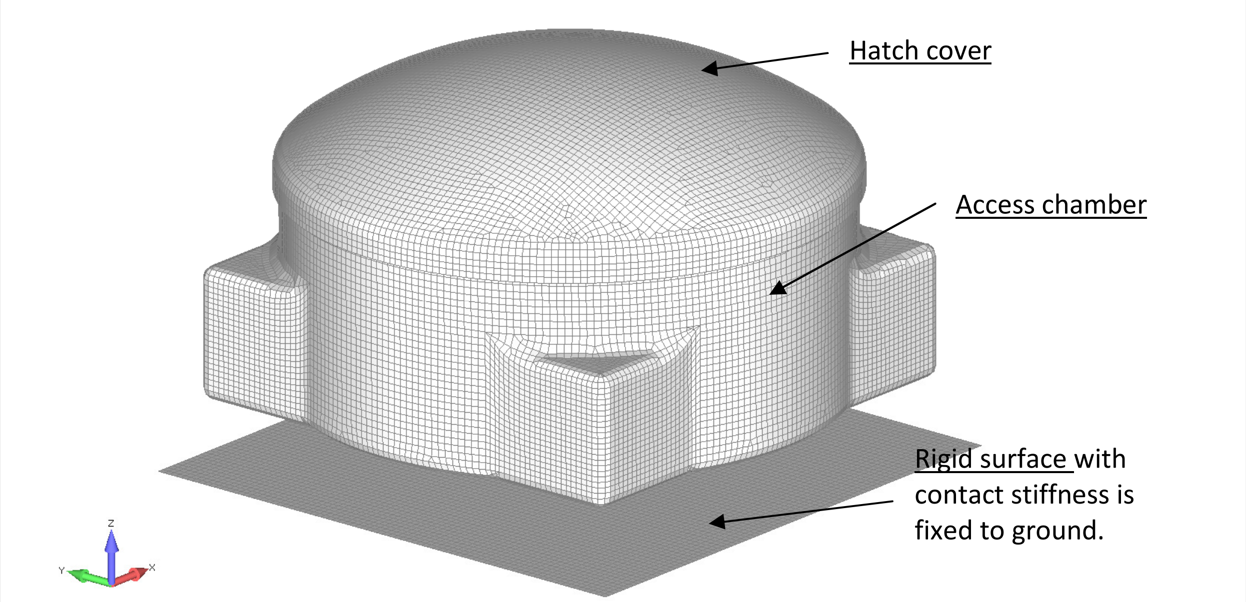


Figure 4-2. Global model of the access chamber

4.4 Model Geometry and Scantlings

Scantlings of the optic access chamber are shown in Figure 4-4. The scantlings are obtained from vendor.

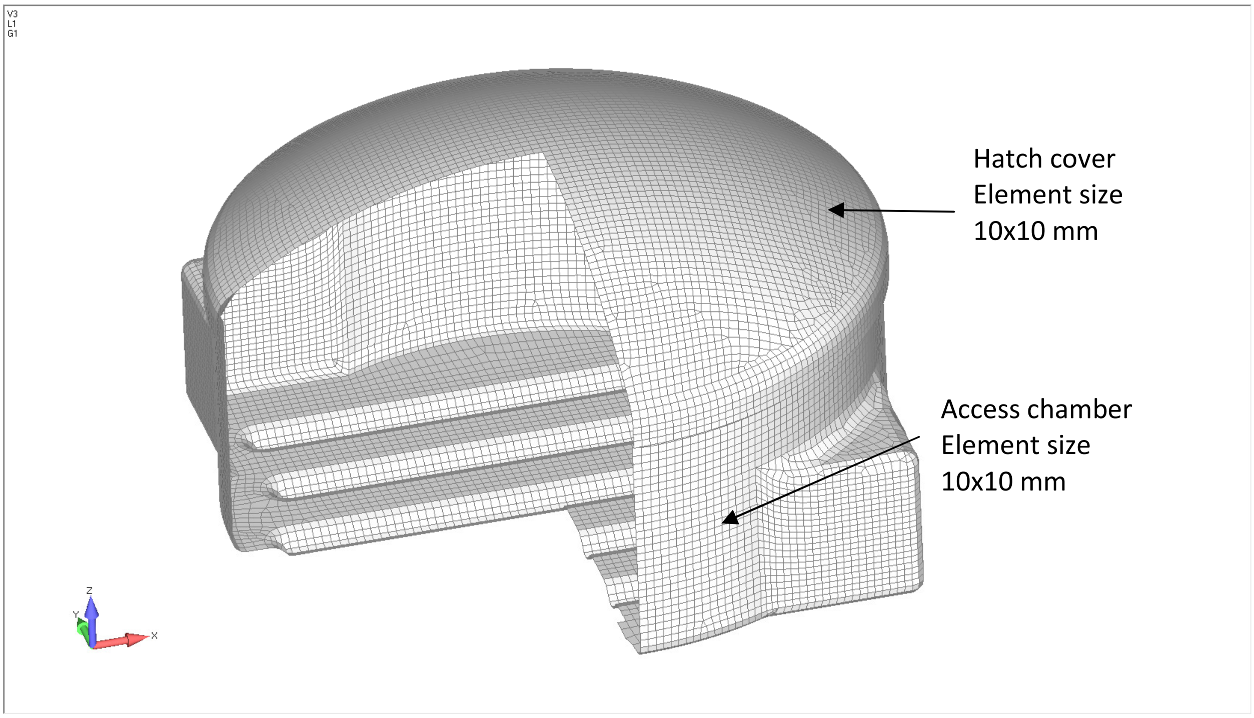


Figure 4-3. Close view of the chain stopper foundations

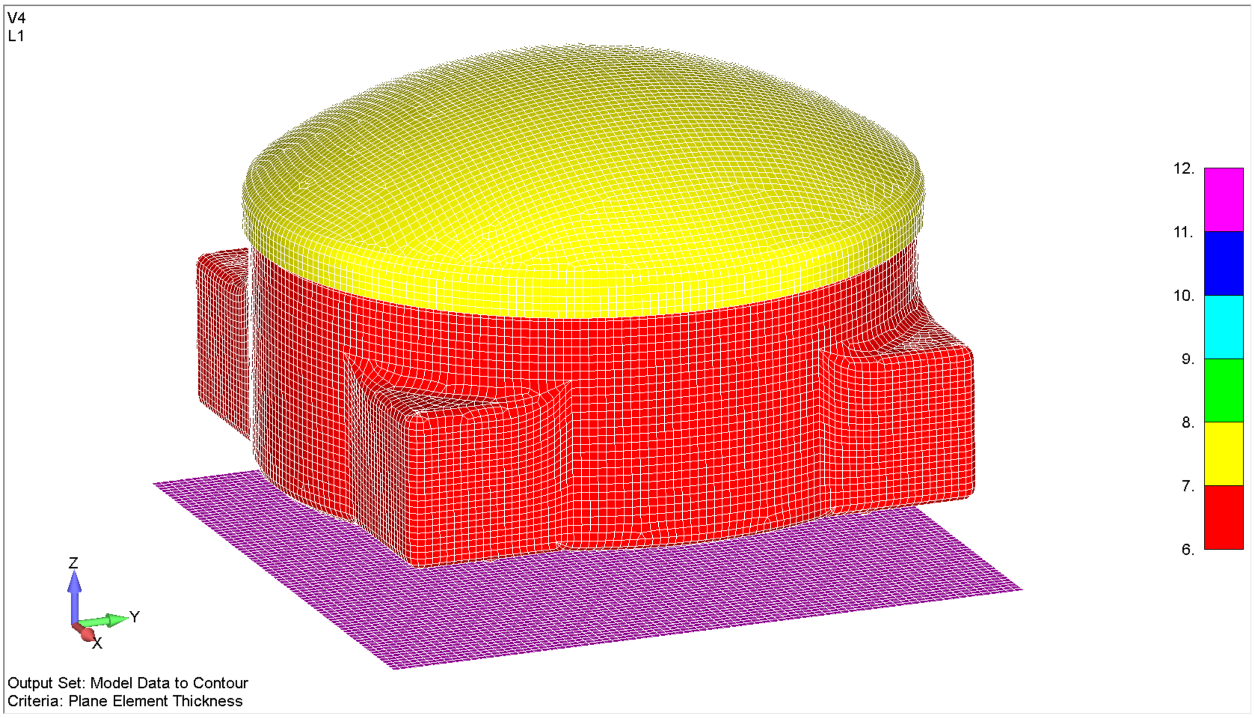


Figure 4-4. Wall thickness for hatch cover and access chamber.

4.5 Boundary conditions

In order to create suitable boundary conditions the optic access chamber was fixed to the ground with help of contact definition. Therefore, the rigid surface with the contact stiffness (Young's modulus E=150 MPa) was created, see Figure 4-5. The contact definition included the friction with the friction coefficient equal to 0.3.

The hatch cover and access chamber were modeled also separately and connected to each other with the contact option.

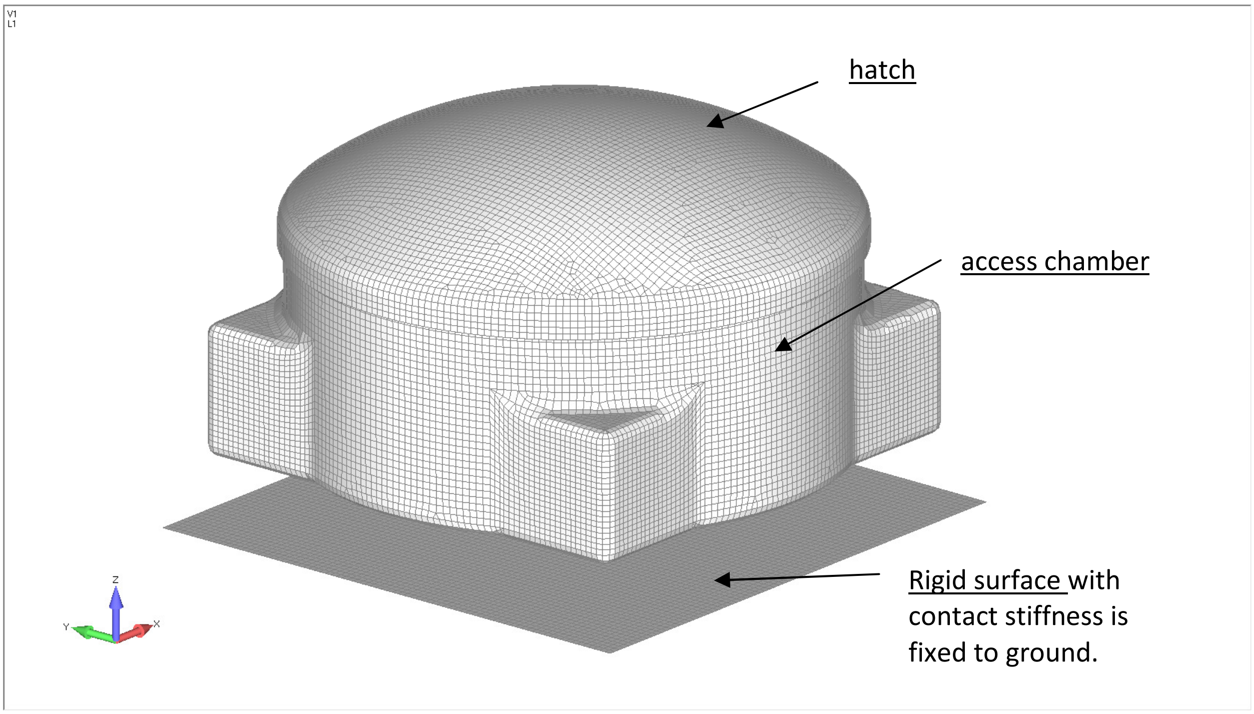


Figure 4-5. Boundary conditions for turret structure.

4.6 Modelling Loads

The loading is applied on hatch cover of access chamber as distributed load. The direction of load is negative z co-ordinate direction. The amplitude of the distributed load is increased in time reaching at the end of simulation the value of 0.03 MPa.

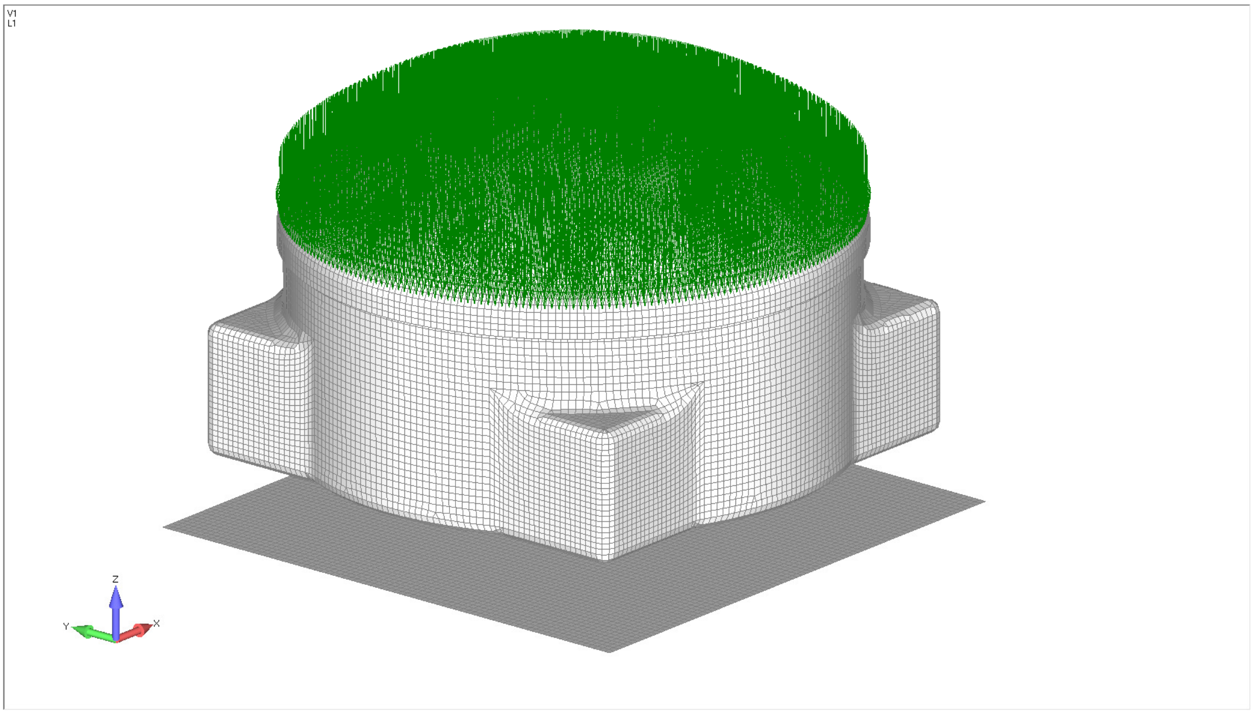


Figure 4-6. Definition of distributed loading for hatch of access chamber.

5 ULTIMATE STRENGTH ANALYSIS RESULTS

As a result of the analysis the contact load between the catch cover and access chamber was calculated, see Figure 5-1. Corresponding deformation modes are shown in Figure 5-2. Results indicate that the optic access chamber will collapse at total vertical load equal to 11 kN which corresponds approximately to 1121 kg of weight. By assuming that the access chamber is installed 0.5 m below the surface the structure has to carry the weight of the soil as well. If the assumed density of soil is 1850 kg/m^3 the soil weight that has to be carried by access chamber is 480 kg. Therefore it can be concluded that the optic access chamber can carry at least 640 kg of load in installed condition. Moreover, it must be noticed that this does not include the supporting effect of soil in installed condition.

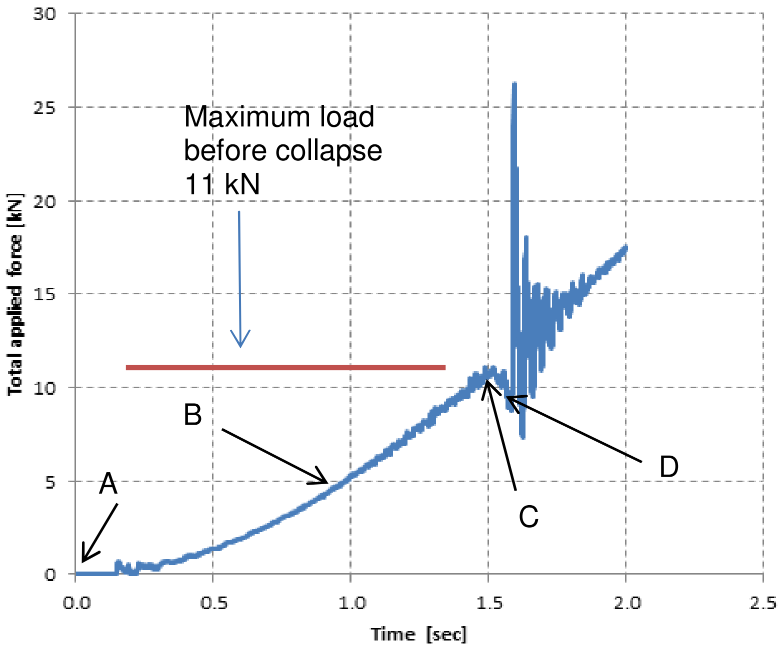
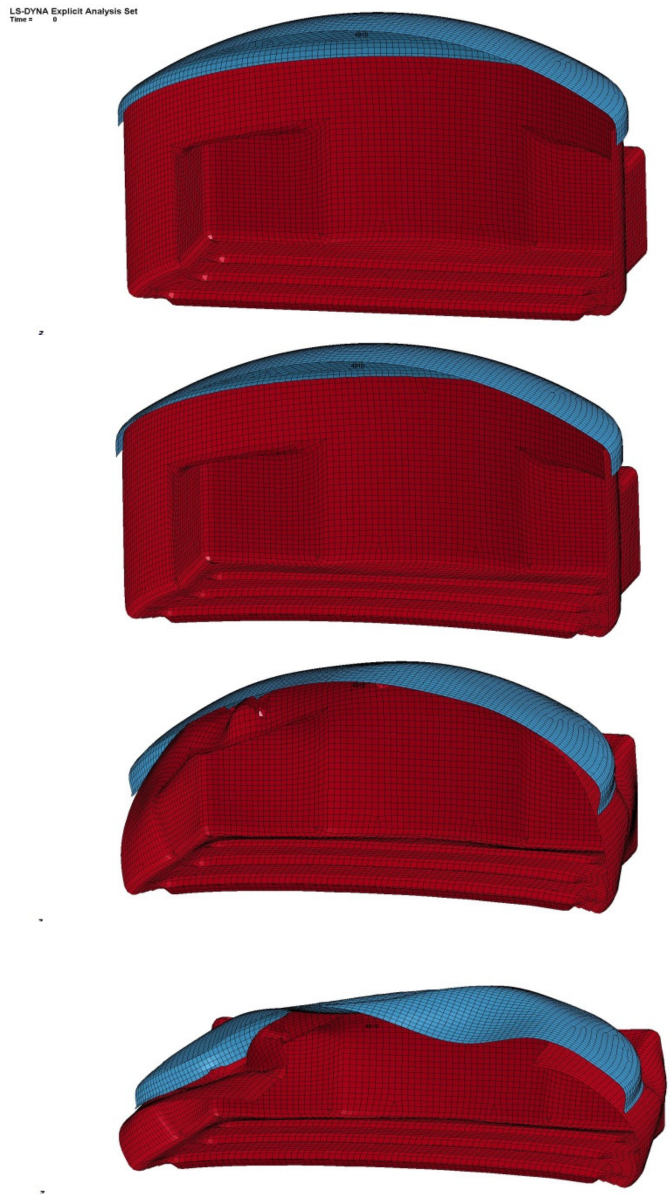


Figure 5-1. Von Mises equivalent stress at top surface external side. Letters correspond to deformation modes presented in next figure



A

B

C

D

Figure 5-2. Collapse of the access chamber at tome t=0 sec, t=0.81 sec, t=1.46 sec and t=1.55 sec