E3S Web of Conferences **402**, 07025 (2023) https://doi.org/10.1051/e3sconf/202340207025
TransSiberia 2023

Actual work's numerical analysis for support joint of vertical cylindrical tank

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Abstract. The article describes the actual work's numerical analysis for unit joining walls to the bottom of vertical cylindrical tank of 50 thousand m^3. Having analyzed the relevant stress-strain state of unit joining walls to the bottom vertical cylindrical tanks for different types of finite element model. Research carried out for the tank with a wall on a rigid base. Features of the unit joining walls to the bottom should include the effect of various loads: static, dynamic, cyclic, corresponding to normal operation. The load on the pressure of the liquid taken appropriate normal operation. Presented and analyzed the main results of numerical studies and get a picture of the stress-strain state of unit joining walls to the bottom vertical cylindrical tank of 50 thousand m^3 for different types of finite element model.

1 Introduction

Presented in the paper materials are part of a range of works, conducted within the framework of research edge effects in the shells of membrane reservoir facilities for storage of liquid and bulk materials [1-3]. Thus, one of the most complex in the calculated plan is unit joining walls to the bottom of tank [4-9].

The main aim of the research is to develop a methodology for determining the adjusted indicators of stress-strain state and evaluation of bearing capacity unit joining walls to the bottom capacitive structures on the example metal tanks with single wall and tanks with a protective wall and reinforced concrete cylindrical silo with a metal funnel [10-12]. The results of studies [2] possible to establish the need to consider unit joining walls to the bottom vertical cylindrical tank a coarsening with the position of engineering calculation, because practice has shown, important that the stresses in the zone unit joining walls to the bottom after 2-3 plum filling cycle disappears through a small local fluidity (i.e. while maintaining the level of loading «wall adapts»).

In this context, the aim of this paper is to clarify the study of the stress-strain state unit joining walls to the bottom vertical cylindrical tank in different types of finite element model on a rigid base.

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https://doi.org/10.1051/e3sconf/202340207025

2 Materials and methods

Numerical studies were conducted on the tank volume of 50 thousand m^3 for the scheme with the rigid structural solution interface wall with the bottom.

For the tank volume of 50 thousand m3 constitute the main parameters: height of wall 18 meters, diameter – 60 meters, the wall thickness of the bottom chord – 30 millimeters. [2,3]

For numerical studies used a universal calculation complex SCAD. For modeling of the model adopted by the enlarged spatial isoparametric finite elements (For wall and floor – 8-nodular of type 36, to weld – 6-nodular of type 34) (fig. 1). Base made tough.

In determining the stresses in the enlarged model sizes 2x2 meters consisting of volumetric elements square, height 50 millimeters, width 50 millimeters, thickness 10 millimeters. (loads correspond meridional and ring stresses in the tank wall). For modeling of a finite element model used finite elements of plate type [11-14] size 25x25 centimeters and thickness 30 millimeters. (fig. 2) [2]. For modeling of walls and bottom are used finite elements of plate type (triangular element of type 42; quadrangular element of type 44). The scheme of loading - the hydrostatic load and gravity load [6,15]. The load on the pressure of the liquid taken appropriate the normal operation.

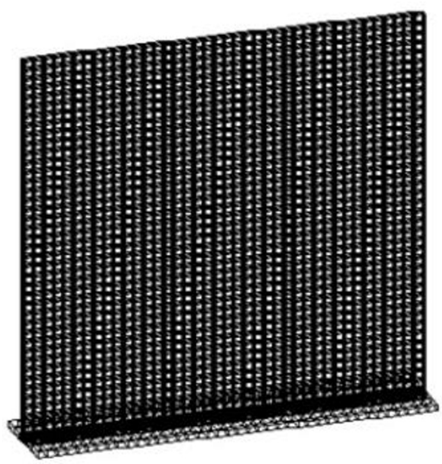

Fig. 1. Design scheme enlarged model made of volumetric items

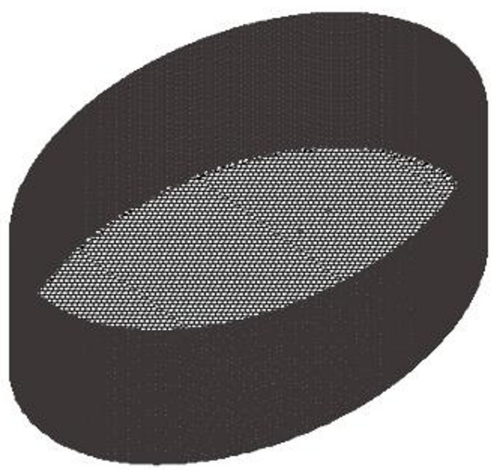

Fig. 2. Design scheme of the tank is made of plate type elements

3 Results

The calculation results at the junction wall with the bottom for the finite element model of volume type presented at fig. 3.

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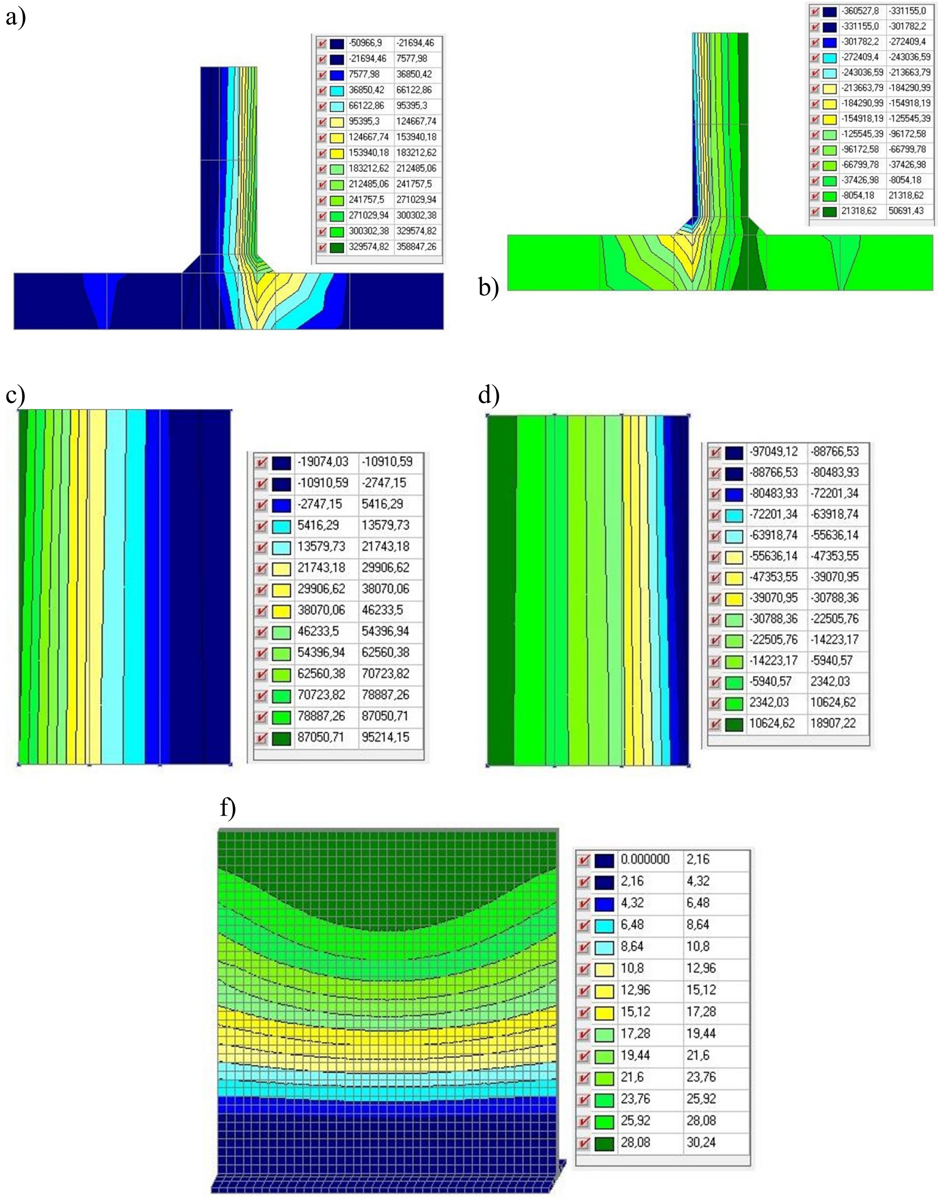

Fig. 3. Results at the junction wall with the bottom for the finite element model volume type:
a) The hoop stress in unit joining walls to the bottom (кН/м^2);
b) Meridional stress in unit joining walls to the bottom (кН/м^2);
c) The hoop stress in the tank wall at a height of 1 meter. (кН/м^2);
d) Meridional stress in the tank wall at a height of 1meter. (кН/м^2);
f) Moving the tank wall (millimeters).

The calculation results at the junction wall with the bottom for the finite element model of plate type presented at fig. 4.

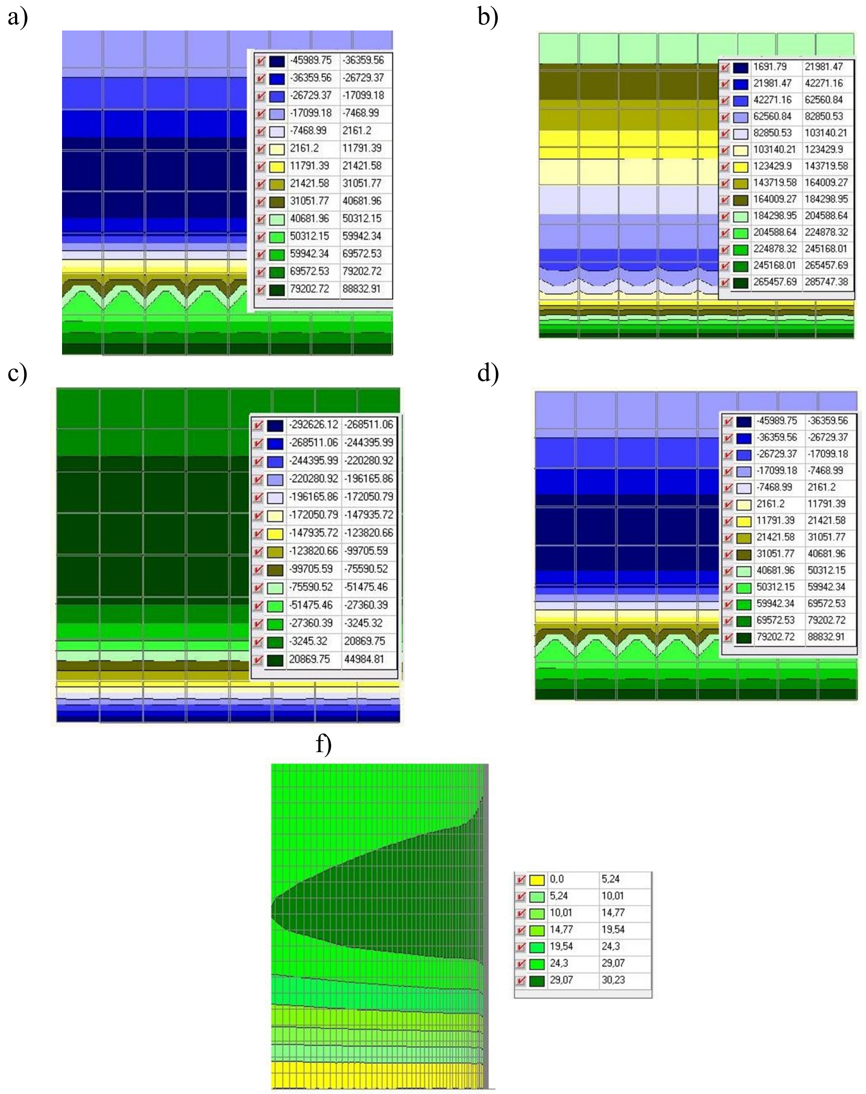

Fig. 4. Results at the junction wall with the bottom for the finite element model plate type:
a) The hoop stress on the outer surface (kN/m^2);
b) The hoop stress on the interior surface (kN/m^2);
c) Meridional stress on the outer surface (kN/m^2);
d) Meridional stress on the interior surface (kN/m^2);
f) Moving the tank wall (millimeters).

In order to summarize the data, the results of calculations in the area of unit joining walls to the bottom node for different types of finite element models are presented in fig. 5-7:

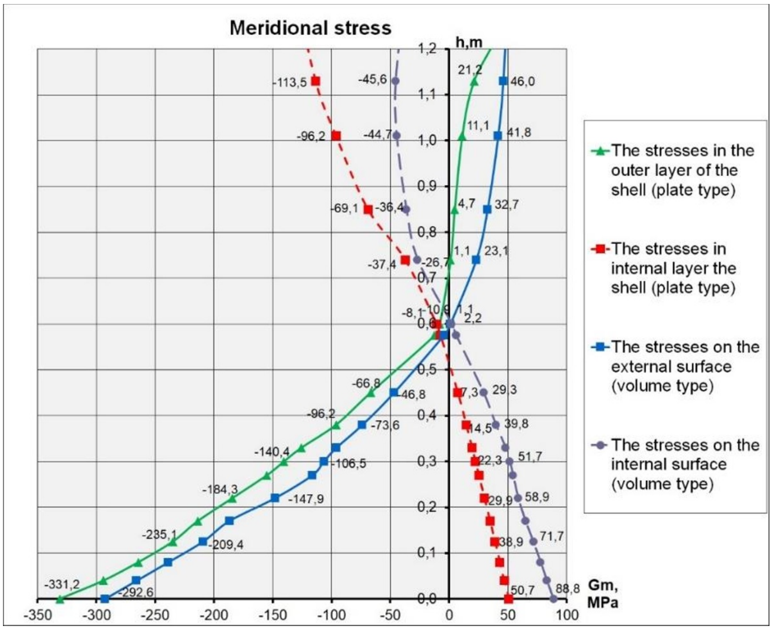

Fig. 5. The values of the meridional stress (σ_m) for unit joining walls to the bottom VCT on a rigid base for the finite element model of plate type and a finite element model of volumetric type.

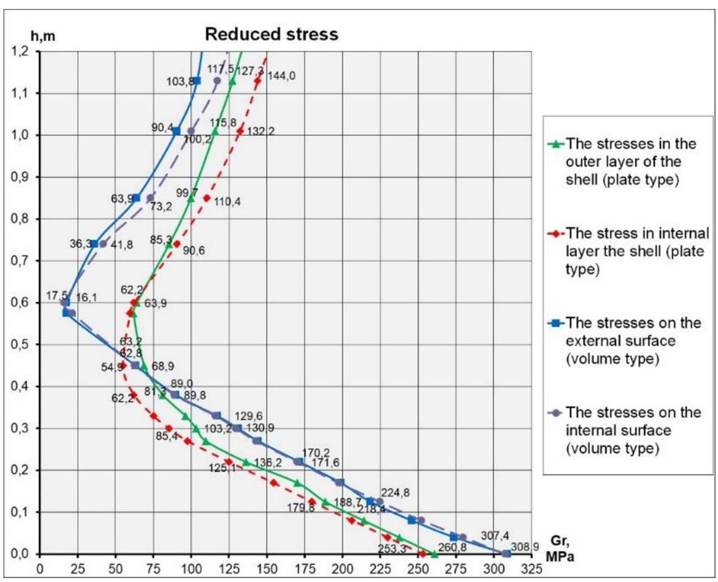

Fig. 6. The values reduced stress (σ_r) for unit joining walls to the bottom VCT on a rigid base for the finite element model of plate type and a finite element model of volumetric type.

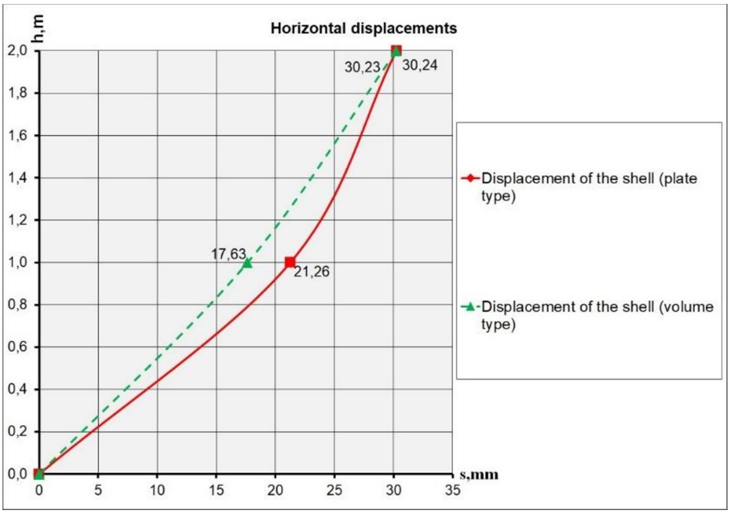

Fig. 7. The values of horizontal displacements (s) for unit joining walls to the bottom VCT on a rigid base for the finite element model of plate type and a finite element model of volumetric type.

4 Conclusions

Analyzing the above results, the following conclusions:

– Analysis meridional stress (σ_m) suggests that in place of the start suture affixed wall to the bottom, the stresses in the volumetric element have greater value on the outer surface up to 13% and minimal value on the inner surface up to 44% compared with a plate member (fig. 5).

– Analysis reduced stress (σ_r) suggests that in place of the start suture anchoring to the bottom wall, the stresses in the volumetric element have greater value on the outer surface up to 18% and the inner surface up to 21% compared with a plate member (fig. 6).

– Analysis displacements at a height of 1 meter a finite element model of volumetric type smaller displacements in the finite element model of the plate type up to 17% (fig. 7).

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