

REINFORCING OF TEMPORARY OPENING IN SHELL OF CYLINDRICAL TANK

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Abstract: For erection of isothermal steel tank it is necessary to remain a temporary opening in the shell. The opening has to be reinforced to be reduced arising stresses and deflections.

Radial shifts of shell around the opening and lifting of bottom are most important and have to be limited with appropriate frame structure.

Key words: shell, opening, stress, deflection, reinforcing

The isothermal tanks are facilities which have double bottom, double shell and double roof. In the space between these constructive elements, during the mounting works, thermal isolation is put in order to facilitate that the temperature of the stored product remain very low and constant.

1. General positions

For erection of isothermal steel tank and mounting of heat insulation between steel bottoms it is necessary to remain a temporary opening in external shell. The opening has to be with dimensions 2540x4000 mm as a half plate in 1th shell course. This temporary opening will be closed after erection of whole external tank – bottom, shell and roof.

The shell has dimensions – diameter $D = 40,0$ m and height $H = 20,98$ m. It is build from steel 52.3 with yield strength $R_y = 355 MPa$. The height of all shell courses is 2540 mm, except the last one. The thickness of the shell courses changes on its height as follows: $t_{is} = 12,11,9,9,8,8,8,8,8$ mm. Roof cover plates have weight 69 t, and roof construction – 105 t.

2. The researches of the opening

The purpose of this research is to determine the required reinforcement of the temporary opening in the shell. It must compensate arising up movements and tensions in the area near to the opening.

For the entire research of the problem the computer 3 D model has been created, in which the tank has been described with its real dimensions and thickness. (fig. 1).

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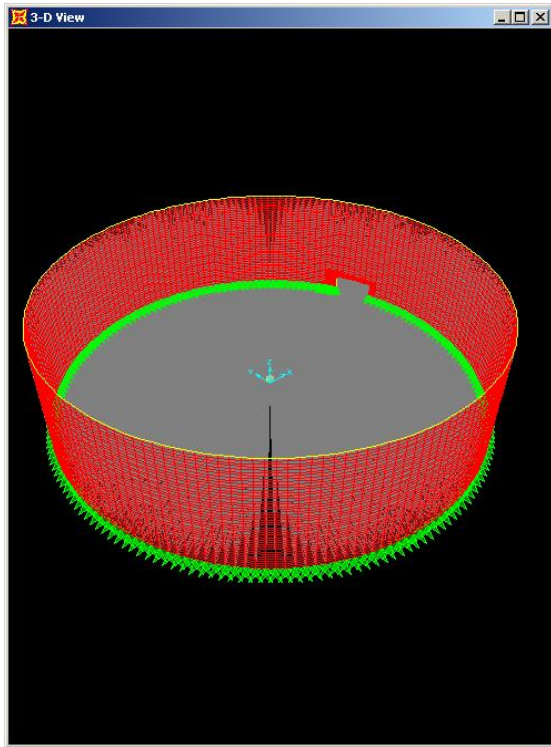


fig. 1 Computer model of the tank with opening in the shell

The accepted material is steel with yield strength $R_y^n = 355\text{MPa}$ and module of elasticity $E = 2,1 \cdot 10^5$ MPa.

The weights of shell and roof are included in the model as dead load.

The opening with dimensions 2540x4200 mm has been done in the shell. It has the full height of the first shell course.

The shell is supported on the bottom without any gaps.

Coordinate systems of shell elements are shown on fig. 2:

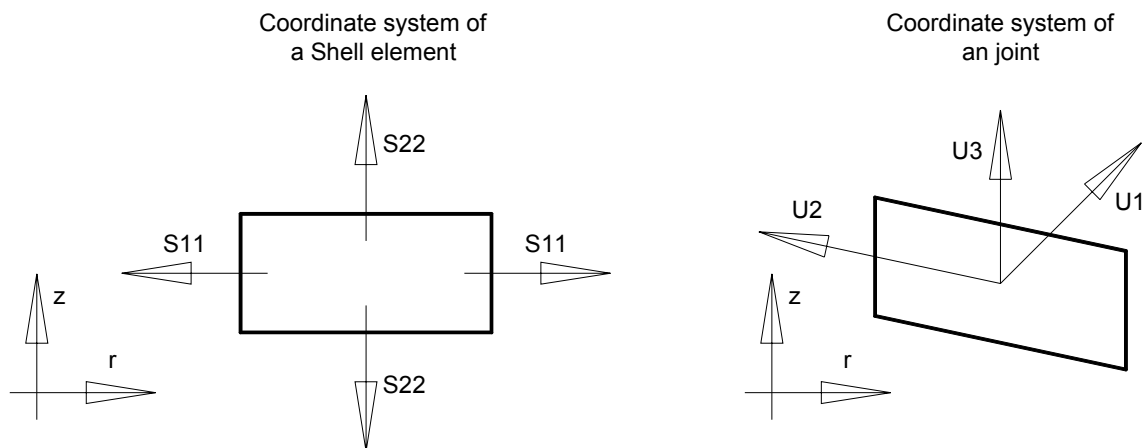


fig. 2 Coordinate systems in 3D model

The first stresses and deflections in the shell near to non reinforced opening have been researched. The calculated results are shown on Table 1:

TABLE 1

Stress, MPa	S ₁₁	S ₂₂
in the middle of opening	2,5	0
in the corner of opening	-86,68	-76,42

Deflections, mm	U ₁	U ₂	U ₃
in the middle of opening	-7	0	-0,9
in the corner of opening	8	2	-0,2

The **Table 1** shows that the maximal stresses in the shell near to the opening are $\sigma_{\max} \approx 0,25.R_y$. They are too small and they are not significant when necessary reinforcement is calculated.

Determinative is the radial movements of free ends of the sheets. Due to this reason reinforcing elements of the opening must be put on the way that they prevent this movement, their stronger moment of inertia to be perpendicular of the shell. The scheme of arrangement of the elements is shown on **fig. 3**:

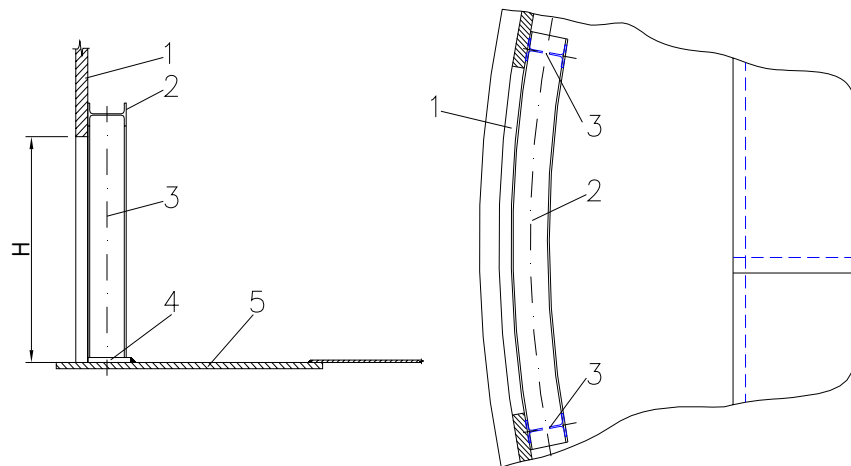


fig. 3 Scheme of the shelf reinforcing sections

- | | | |
|----------------------------|------------------------|----------------------------------|
| 1. Tank's shell | 3. Column of the frame | 5. Peripheral ring of the bottom |
| 2. Reinforcing arc element | 4. Base plate | |

When reinforcement of the opening is done with various hot rolled sections, the following stresses and deflections are appeared in the shell (**Table 2**):

TABLE 2

Section IPE160

Stress, MPa	S ₁₁	S ₂₂
in middle of opening	1,63	0
in corner of opening	-62,55	-81,09

Deflection, mm	U1	U2	U3
in middle of opening	-1	0	-0,7
in corner of opening	2	1	-0,2

Section IPE200

Stress, MPa	S ₁₁	S ₂₂
in middle of opening	1,14	0
in corner of opening	-49,62	-71

Deflection, mm	U1	U2	U3
in middle of opening	-0,4	0	-0,7
in corner of opening	1	0,5	-0,1

3. Conclusions

a) when temporary shell's opening is rectangular, the most important are radial deflections. Due to this reason the reinforcement must prevent radial deformation;

b) framing around the opening with sections with bigger stiffness decreases very much deflections but has a slight influence upon the tension .

4. Recommendation for execution of the reinforcement

During the shell's erection and increasing of loads upon the earth basement it is possible annular plates to lift (fig. 4).



fig. 4 Lifting of the bottom

The inevitable appearance of deformations in the steel bottom must be prevented with jacking system or convenient reinforcement (fig.5).

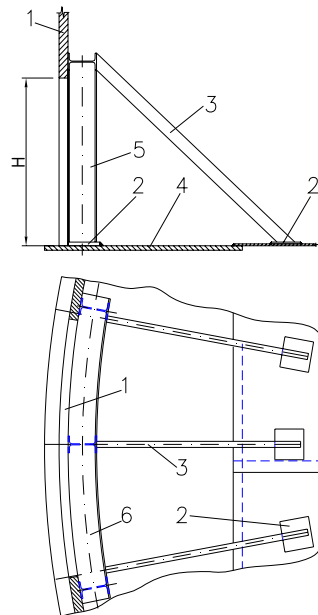


fig. 5 Temporary reinforcing shell and bottom ribs

- 1. Tank shell
- 2. Base plate

- 3. Supporting frame
- 4. Annular bottom plate

- 5. Supporting column
- 6. Reinforcing arc element