Spherical shells (7.4.3) according to standards EN 13445-3

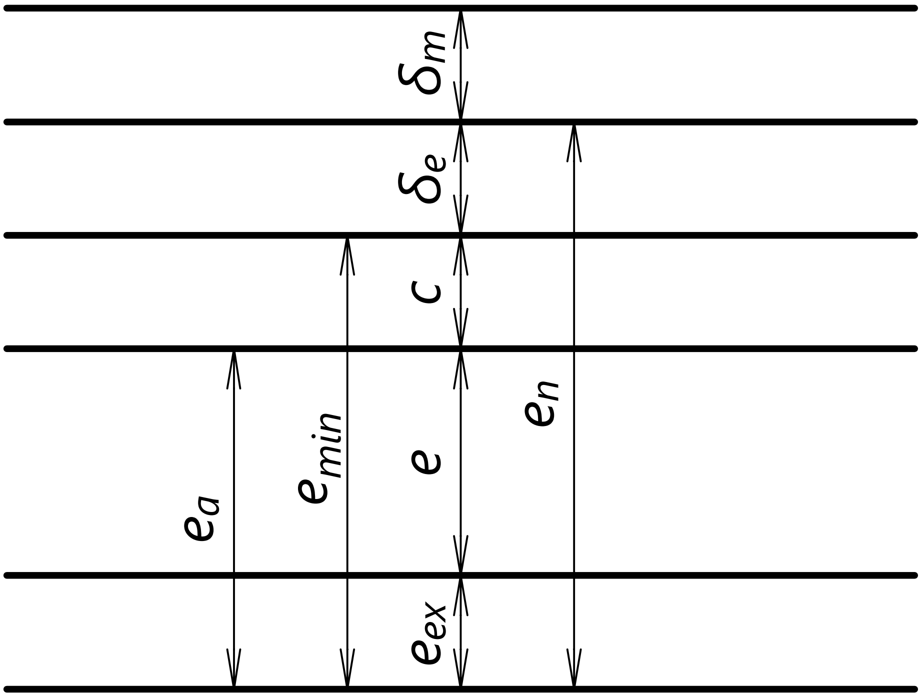

Fig. 1 - The inter-relation of the various definitions of thickness

Values for calculation:

The calculation pressure P 2 MPa

The test pressure P_{test} 3 MPa

The inside diameter of shell D_i 1000 mm

Material P235GH+N (1.0345)

The nominal thickness e_n 10 mm

Temperature for normal operating cases T 100 C°

Temperature for test cases T_{test} 20 C°

The minimum yield strength or 0.2% proof strength at calculation temperature $R_{p0.2/T}$ 214 MPa

The minimum tensile strength at 20°C $R_{m/20}$ 360 MPa

The minimum yield strength or 0.2% proof strength at test temperature $R_{p0.2/T_{test}}$ 235 MPa

The minimum tensile strength at test temperature $R_{m/T_{test}}$ 360 MPa

Testing group 4

Joint coefficient z 0.7

The corrosion allowance c 2 mm

The absolute value of the possible negative tolerance on the nominal thickness (EN 10029) $quality$ B

Limit values of weld joint defects (EN ISO 5817) $quality$ C

The nominal design stress for normal operating cases:

$$f_d = \min\left(\frac{R_{p0.2/T}}{1.5}; \frac{R_{m/20}}{2.4}\right) \cdot 0.9 = \min\left(\frac{214}{1.5}; \frac{360}{2.4}\right) \cdot 0.9 = 128.4\text{MPa}$$

The nominal design stress for test cases:

$$f_{test} = \frac{R_{p0.2/T_{test}}}{1.05} \cdot 0.9 = \frac{235}{1.05} \cdot 0.9 = 201.4\text{MPa}$$

The required thickness for calculation pressure:

$$e = \frac{P \cdot D_i}{4f_d \cdot z - P} = \frac{2 \cdot 1000}{4 \cdot 128.4 \cdot 0.7 - 2} = 5.6\text{mm}$$

The required thickness for test pressure:

$$e_{test} = \frac{P_{test} \cdot D_i}{4f_{test} \cdot z - P_{test}} = \frac{3 \cdot 1000}{4 \cdot 201.4 \cdot 0.7 - 3} = 5.3\text{mm}$$

Tolerance on the nominal thickness (EN 10029):

$$\delta_{e1} = 0.3\text{mm}$$

Linear offset between plates (EN 5817):

$$\delta_{e2} = \min\left(0.2 + 0.15e_n; 4\right) = \min\left(0.2 + 0.15 \cdot 10; 4\right) = 1.7\text{mm}$$

Defects of welds:

$$\delta_{e3} = 0.3e_n \cdot 0.08 = 0.3 \cdot 10 \cdot 0.08 = 0.2\text{mm}$$

The mean diameter of shell:

$$D_m = D_i + e_n = 1000 + 10 = 1010\text{mm}$$

The analysis thickness:

$$e_a = e_n - \delta_{e1} - \delta_{e2} - \delta_{e3} - c = 10 - 0.3 - 1.7 - 0.2 - 2 = 5.8\text{mm}$$

Maximum pressure for normal operating loads:

$$P_{max} = \frac{4f_d \cdot z \cdot e_a}{D_m} = \frac{4 \cdot 128.4 \cdot 0.7 \cdot 5.8}{1010} = 2.1\text{MPa}$$

$$P \leq P_{max} \rightarrow 2 \leq 2.1$$

Does suit.

Maximum pressure for test loads:

$$P_{max-test} = \frac{4f_{test} \cdot z \cdot e_a}{D_m} = \frac{4 \cdot 201.4 \cdot 0.7 \cdot 5.8}{1010} = 3.2\text{MPa}$$

$$P_{test} \leq P_{max-test} \rightarrow 3 \leq 3.2$$

Does suit.