Tank Design
Yesterday – Today - Tomorrow

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Design Methods

- Analysis Methods

\[ n^\beta = \int_{-h/2}^{h/2} \left( \delta_{\nu}^\beta - \delta_{\nu}^3 b_{\nu}^\beta \right) \sigma^{\alpha\beta} \, d\theta^3 - \bar{m}^{\alpha\beta} - \bar{m}^{\alpha\beta} b_{\nu}^\beta \]

\[ m^\beta = \int_{-h/2}^{h/2} \left( \delta_{\nu}^\beta - \delta_{\nu}^3 b_{\nu}^\beta \right) \theta^3 \sigma^{\nu\mu} \, d\theta^3 - \bar{m}^{\nu\mu} - \bar{m}^{\nu\mu} b_{\nu}^\beta \equiv \bar{m}^{\nu\mu} \]

\[ q^\alpha = \int_{-h/2}^{h/2} \sigma^{\alpha\nu} \, d\theta^3 \]
Design Methods

- Sample Calculations and Standards
  - DVS - Merkblatt 2205 -1 ÷ 2205 - 5
  - Musterberechnung 40 – B1 (Stehende Behälter)
  - Musterberechnung 40 – B2 (Liegende Behälter)
- Norm prEN 13121
Software

Engineering Software Solutions based on **DVS Merkblätter 2205**

- Stable Program Flow?
- Software technology State of the Art?
- All common types of tanks designable?
- Comfortable data processing?
- Output checkable?
- Software network- and cloud ready?
Problem area of the DVS
Example: Rectangular tanks

Merkblatt DVS 2205 Teil 5

- The mechanical structural concept very simple
- Restrictive and partially wrong
- No longer contemporary
- No alignment with existing steel design standards
- Uncontrolled mixing within the measurement of modern steel construction standards and the DVS concept
Example of the dimensioning of a rectangular tank with full-perimeter reinforcements

Rectangular tank
h = 3,00 m, b = 4,00 m
Wall thickness
t = 20,00 mm
γ\text{Med} = 10,00 kN/m²

Field Length at the lower edge
b₁ = 214 mm

Profile width
b_{\text{Prof}} = 82,0 mm (IPE 160)

FEM/DVS = 1,76
Model building at the reinforcement areas for rectangular tanks

$m_{1d} = q_1 \cdot b_1^2 / 12$

Sidewall model

Elastical embedding area
Problem areas of the DVS
Example: Tank bottoms

- **Flat bottoms**
  - ✔ State of the Art

- **Sloped bottoms**
  - ✔ Constructionally complex but possible

- **Ring supported conical bottoms**
  - ✔ Constructionally complex
  - ✔ All adoptions of the model building constructionally possible?

- **Segment bottoms**
  - ✔ Constructionally a quite simple construction
  - ✔ Many statical Advantages

Currently no regulations for the design
Finite Elemente Method

- Dlubal
- Microfe
- Ansys
- Adina
- Abacus

and many, many more
Disadvantages of the FEM

**Finite Elemente Method**

- High initial costs
- Long training period
- Only qualified personnel
- Work- and time-consuming project handling
Tank dimensioning of tomorrow

How does it work?

- Core Software
- Software Organization
- Access to the Software
- Data structure
Core software

- Object-oriented programming
- Intuitive user guidance
- Stable program flow with high performance
- Input check
  - Validation instead of error messages
- Structured data saving → XML (human readable)
- Clear and strict separation between In-/Output
  and the real data
  → Layer model
Layer model

Administration software
- Customer Management
- Material data
- Media lists
- Steel profiles
- Envelope profiles
- Plate sizes and -thickness
- In- and output management
- Individual settings

Expert software
- Circular tanks
- Rectangular tanks
- Special modules
- FEM
- CAD
- Pricing

Computational Core

Output
Access to the Software

IFKI – Always a good choice

Cloud
- Real-time update of all modules and data
- Communication with Intranet and clients
Software organization

Cloud
- Updating of all modules and data in real time
- Communication with the Intranet and Clients
  - Central database (e.g. SimChem)
  - Shares

Encrypted!

Company Intranet
- Central management
- Simple and comfortable Administration

Encrypted!

PC / Laptop

Mobile device Requirement: Browser
Summary

What is essential?
- Object-oriented programming
- Stable program flow with validation
- Structured data storage and exchange formats
- Comfortable administration module

What is desirable?
- Universal communication
- Integrated additional tools (FEM, CAD, Pricing)
- Real Time Updates and Cloud capability

Where does this lead to?
User \[\Rightarrow\] Software producer

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