Arbeitsausschuß "Ufereinfassungen" der Hafentechnischen Gesellschaft e.V. Recommendations of the Committee for Waterfront Structures Harbours and Waterways 9., completely revised Edition

TABLE OF CONTENTS

0 Structural calculations

- 0.1 General
- 0.2 Safety concept
- 0.3 Calculations for waterfront structures

1 Subsoil

- 1.1 Mean characteristic values of soil parameters (R 9)
- 1.2 Layout and depths of boreholes and penetrometer tests (R 1)
- 1.3 Geotechnical report (R 150)
- 1.4 Determining the shear strength cu of saturated, undrained cohesive
- 1.5 Assessing the subsoil for the installation of piles and sheet piles and for selecting the installation method (R 154)

2 Active and passive earth pressure

- 2.1 General
- 2.2 Considering the cohesion in cohesive soils (R 2)
- 2.3 Considering the apparent cohesion (capillary cohesion) in sand (R 3)
- 2.4 Determining active earth pressure according to the Culmann method
- 2.5 Active earth pressure in stratified soil (R 219)
- 2.6 Determining active earth pressure for a steep, paved embankment in a partially sloping waterfront structure (R 198)
- 2.7 Determining the active earth pressure shielding on a wall below a relieving platform with average ground surcharges (R 172)
- 2.8 Earth pressure distribution under limited loads (R 215)
- 2.9 Determining active earth pressure in saturated, non- or partially consolidated, soft cohesive soils (R 130)
- 2.10 Effect of artesian water pressure under harbour bottom or river bed on active and passive earth pressures (R 52)
- 2.11 Considering active earth pressure and excess water pressure, and construction guidance for waterfront structures with soil replacement and contaminated or disturbed base of excavation (R 110)
- 2.12 Effect of groundwater flow on excess water pressure and active and passive earth pressures (R 114)
- 2.13 Determining the amount of displacement required for mobilising passive earth pressure in non-cohesive soils (R 174)
- 2.14 Measures for increasing the passive earth pressure in front of waterfront structures (R 164)
- 2.15 Passive earth pressure in front of abrupt changes in ground level in soft cohesive soils with rapid load application on land side (R 190)
- 2.16 Waterfront structures in seismic regions (R 124)

3 Hydraulic heave failure, ground failure

- 3.1 Safety against hydraulic heave failure (R 115)
- 3.2 Piping (ground failure due to internal erosion) (R 116)





Ernst & Sohn

9th Edition

4 Water levels, water pressure, drainage

- 4.1 Mean groundwater level (R 58)
- 4.2 Excess water pressure in direction of water side (R 19)
- 4.3 Excess water pressure on sheet piling in front of embankments below elevated platforms in tidal areas (R 65)
- 4.4 Design of weepholes for sheet piling structures (R 51)
- 4.5 Design of drainage systems for waterfront structures in tidal areas (R 32)
- 4.6 Relieving artesian pressure beneath harbour bottoms (R 53)
- 4.7 Taking account of groundwater flow (R 113)
- 4.8 Temporary stabilisation of waterfront structures by groundwater lowering (R 166)

5 Ship dimensions and loads on waterfront structures

- 5.1 Ship dimensions (R 39)
- 5.2 Berthing force of ships at quays (R 38)
- 5.3 Berthing velocities of ships transverse to berth (R 40)
- 5.4 Design situations (R 18)
- 5.5 Vertical imposed loads (R 5)
- 5.6 Determining the "design sea state" for maritime and port structures (R 136)
- 5.7 Wave pressure on vertical quay walls in coastal areas (R 135)
- 5.8 Loads arising from surging and receding waves due to the inflow or outflow of water (R 185)
- 5.9 Effects of waves due to ship movements (R 186)
- 5.10 Wave pressure on piled structures (R 159)
- 5.11 Wind loads on moored ships and their influence on the dimensioning of mooring and fender equipment (R 153)
- 5.12 Layout of and loads on bollards for sea-going vessels (R 12)
- 5.13 Layout, design and loading of bollards for inland facilities (R 102)
- 5.14 Quay loads from cranes and other transhipment equipment (R 84)
- 5.15 Impact and pressure of ice on waterfront structures, fenders and dolphins in coastal areas (R 177)
- 5.16 Impact and pressure of ice on waterfront structures, piers and dolphins at inland facilities (R 205)
- 5.17 Loads on waterfront structures and dolphins caused by fender reaction forces (R 213)

6 Configuration of cross-sections and equipment for waterfront structures

- 6.1 Standard cross-section dimensions for waterfront structures in seaports (R 6)
- 6.2 Top edges of waterfront structures in seaports (R 122)
- 6.3 Standard cross-sections for waterfront structures in inland ports (R 74)
- 6.4 Sheet piling waterfronts on inland waterways (R 106)
- 6.5 Upgrading partially sloped waterfronts in inland ports with large water level fluctuations (R 119)
- 6.6 Design of waterfront areas in inland ports according to operational aspects (R 158)
- 6.7 Nominal depth and design depth of harbour bottom (R 36)
- 6.8 Strengthening waterfront structures for deepening harbour bottoms in seaports (R 200)
- 6.9 Embankments below waterfront wall superstructures behind closed sheet pile walls (R 68)
- 6.10 Redesign of waterfront structures in inland ports (R 201)
- 6.11 Provision of quick-release hooks at berths for large vessels (R 70)
- 6.12 Layout and design of and loads on access ladders (R 14)
- 6.13 Layout and design of stairs in seaports (R 24)
- 6.14 Equipment for waterfront structures in seaports with supply and disposal systems (R 173)
- 6.15 Fenders for large vessels (R 60)



- 6.16 Fenders in inland ports (R 47)
- 6.17 Foundations to craneways on waterfront structures (R 120)
- 6.18 Fixing crane rails to concrete (R 85)
- 6.19 Connection of expansion joint seal in reinforced concrete bottom to loadbearing steel sheet pile wall (R 191)
- 6.20 Connecting steel sheet piling to a concrete structure (R 196)
- 6.21 Floating berths in seaports (R 206)

7 Earthworks and dredging

- 7.1 Dredging in front of quay walls in seaports (R 80)
- 7.2 Dredging and hydraulic fill tolerances (R 139)
- 7.3 Hydraulic filling of port areas for planned waterfront structures (R 81)
- 7.4 Backfilling of waterfront structures (R 73)
- 7.5 In situ density of hydraulically filled non-cohesive soils (R 175)
- 7.6 In situ density of dumped non-cohesive soils (R 178)
- 7.7 Dredging underwater slopes (R 138)
- 7.8 Subsidence of non-cohesive soils (R 168)
- 7.9 Soil replacement along a line of piles for a waterfront structure (R 109)
- 7.10 Dynamic compaction of the soil (R 188)
- 7.11 Vertical drains to accelerate the consolidation of soft cohesive soils (R 93)
- 7.12 Consolidation of soft cohesive soils by preloading (R 179)
- 7.13 Improving the bearing capacity of soft cohesive soils with vertical elements (R 210)

8 Sheet piling structures

- 8.1 Materials and construction
- 8.1.1 Design and installation of timber sheet pile walls (R 22)
- 8.1.2 Design and installation of reinforced concrete sheet pile walls (R 21)
- 8.1.3 Design and installation of steel sheet pile walls (R 34)
- 8.1.4 Combined steel sheet piling (R 7)
- 8.1.5 Shear-resistant interlock connections for steel sheet piling (R 103)
- 8.1.6 Quality requirements for steels and dimensional tolerances for steel sheet piles (R 67)
- 8.1.7 Acceptance conditions for steel sheet piles and steel piles on site (R 98)
- 8.1.8 Corrosion of steel sheet piling, and countermeasures (R 35)
- 8.1.9 Danger of sand abrasion on sheet piling (R 23)
- 8.1.10 Blasting to assist the driving of steel sheet piles (R 183)
- 8.1.11 Driving steel sheet piles (R 118)
- 8.1.12 Driving combined steel sheet piling (R 104)
- 8.1.13 Monitoring during the installation of sheet piles, tolerances (R 105)
- 8.1.14 Noise control low-noise driving (R 149)
- 8.1.15 Driving of steel sheet piles and steel piles at low temperatures (R 90)
- 8.1.16 Repairing interlock declutching on driven steel sheet piling (R 167)
- 8.1.17 Reinforced steel sheet piling (R 176)
- 8.1.18 Design of piling frames (R 140)
- 8.1.19 Design of welded joints in steel piles and steel sheet piles (R 99)
- 8.1.20 Cutting off the tops of driven steel sections for loadbearing welded connections (R 91)
- 8.1.21 Watertightness of steel sheet piling (R 117)
- 8.1.22 Waterfront structures in regions with mining subsidence (R 121)
- 8.1.23 Vibratory driving of U- and Z-section steel sheet piles (R 202)
- 8.1.24 Water-jetting to assist the driving of steel sheet piles (R 203)
- 8.1.25 Pressing of U- and Z-section steel sheet piles (R 212)
- 8.2 Design of sheet piling
- 8.2.1 General
- 8.2.2 Free-standing sheet piling structures (R 161)
- 8.2.3 Design of sheet piling structures with fixity in the ground and a single anchor (R 77)
- 8.2.4 Design of sheet pile walls with double anchors (R 134)



- 8.2.5 Applying the angle of earth pressure and the analysis in the vertical direction (R 4)
- 8.2.6 Taking account of unfavourable groundwater flows in the passive earth pressure zone (R 199)
- 8.2.7 Verifying the loadbearing capacity of the elements of sheet piling structures (R 20)
- 8.2.8 Selection of embedment depth for sheet piling (R 55)
- 8.2.9 Determining the embedment depth for sheet pile walls with full or partial fixity in the soil (R 56)
- 8.2.10 Steel sheet piling with staggered embedment depths (R 41)
- 8.2.11 Horizontal actions on steel sheet pile walls in the longitudinal direction of the quay (R 132)
- 8.2.12 Design of anchor walls fixed in the ground (R 152)
- 8.2.13 Staggered arrangement of anchor walls (R 42)
- 8.2.14 Steel sheet piling founded on bedrock (R 57)
- 8.2.15 Waterfront sheet piling in unconsolidated, soft cohesive soils, especially in connection with non-sway structures (R 43)
- 8.2.16 Design of single-anchor sheet piling structures in earthquake zones (R 125)8.3 Design of cofferdams
- 8.3.1 Cellular cofferdams as excavation enclosures and waterfront structures (R 100)
- 8.3.2 Double-wall cofferdams as excavation enclosures and waterfront structures (R 101)
- 8.3.3 Narrow moles in sheet piling (R 162)
- 8.4 Walings, capping beams and anchor connections
- 8.4.1 Design of steel walings for sheet piling (R 29)
- 8.4.2 Verification of steel walings (R 30)
- 8.4.3 Sheet piling walings of reinforced concrete with driven steel anchor piles (R 59)
- 8.4.4 Steel capping beams for sheet piling waterfront structures (R 95)
- 8.4.5 Reinforced concrete capping beams for waterfront structures with steel sheet piling (R 129)
- 8.4.6 Steel nosings to protect reinforced concrete walls and capping beams on waterfront structures (R 94)
- 8.4.7 Auxiliary anchors at the top of steel sheet piling structures (R 133)
- 8.4.8 Screw threads for sheet piling anchors (R 184)
- 8.4.9 Sheet piling anchors in unconsolidated, soft cohesive soils (R 50)
- 8.4.10 Design of protruding quay wall corners with round steel tie rods (R 31)
- 8.4.11 Design and calculation of protruding quay wall corners with raking anchor piles (R 146)
- 8.4.12 High prestressing of anchors of high-strength steel for waterfront structures (R 151)
- 8.4.13 Hinged connections between driven steel anchor piles and steel sheet piling structures (R 145)
- 8.5 Verification of stability for anchoring at the lower failure plane (R 10)
- 8.5.1 Stability at the lower failure plane for anchorages with anchor walls
- 8.5.2 Stability at the lower failure plane in unconsolidated, saturated cohesive soils
- 8.5.3 Stability at the lower failure plane with varying soil strata
- 8.5.4 Verification of stability at the lower failure for a quay wall fixed in the soil
- 8.5.5 Stability at the lower failure plane for an anchor wall fixed in the soil
- 8.5.6 Stability at the lower failure plane for anchors with anchor plates
- 8.5.7 Verification of safety against failure of anchoring soil
- 8.5.8 Stability at the lower failure plane for quay walls anchored with anchor piles or grouted anchors at one level
- 8.5.9 Stability at the lower failure plane for quay walls with anchors at more than one level
- 8.5.10 Safety against slope failure

9. Tension piles and anchors (R 217)

- 9.1 General
- 9.2 Displacement piles
- 9.3 Micropiles
- 9.4 Special piles
- 9.5 Anchors





10. Quay walls and superstructures in concrete

- 10.1 Design principles for quay walls and superstructures in concrete (R 17)
- 10.2 Design and construction of reinforced concrete components in waterfront structures (R 72)
- 10.3 Formwork in areas affected by tides and waves (R 169)
- 10.4 Box caissons as waterfront structures in seaports (R 79)
- 10.5 Compressed-air caissons as waterfront structures (R 87)
- 10.6 Design and construction of block-type quay walls (R 123)
- 10.7 Design of quay walls using open caissons (R 147)
- 10.8 Design and construction of solid waterfront structures (e.g. blocks, box caissons, compressed-air caissons) in earthquake zones (R 126)
- 10.9 Use and design of bored cast-in-place piles (R 86)
- 10.10 Use and design of diaphragm walls (R 144)
- 10.11 Survey prior to repairing concrete components in hydraulic engineering structures (R 194)
- 10.12 Repairing concrete components in hydraulic engineering structures (R 195)

11 Pile bents and trestles

- 11.1 General
- 11.2 Calculating subsequently strengthened pile bents/trestles (R 45)
- 11.3 Design of plane pile bents (R 78)
- 11.4 Design of spatial pile trestles (R 157)
- 11.5 Design of piled structures in earthquake zones (R 127)

12 Protection and stabilisation structures

- 12.1 Embankment stabilisation on inland waterways (R 211)
- 12.2 Slopes in seaports and tidal inland ports (R 107)
- 12.3 Use of geotextile filters in bank and bottom protection (R 189)
- 12.4 Scour and protection against scour in front of waterfront structures
- 12.5 Scour protection at piers and dolphins
- 12.6 Installation of mineral impervious linings underwater and their connection to waterfront structures (R 204)
- 12.7 Flood defence walls in seaports (R 165)
- 12.8 Dumped moles and breakwaters (R 137)

13 Dolphins (R 218)

- 13.1 General principles
- 13.2 Design of dolphins
- 13.3 Construction and arrangement of dolphins

14 Inspection and monitoring of waterfront structures (R 193)

- 14.1 General
- 14.2 Documentation
- 14.3 Carrying out structural inspections
- 14.4 Inspection intervals
- 14.5 Maintenance management systems

