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1. Range of applicability

This Standard applies to the protection of watercourses, dikes, and costal dunes.

It does not apply to structures requiring special design (e. g., the construction of dikes, bottom drop-offs, diversion dams).

2. Concept

Protection in the sense of this Standard means structural-engineering and biological-engineering measures for protecting the bottoms and banks of navigable and nonnavigable watercourses, dikes, and costal dunes against damage and destruction. This also includes shoring up slopes in order to protect watercourses.

For further definitions see DIN 4047 and DIN 4049.

3. Considerations in the choice of protection devices

The protection of watercourses should be carried out by methods which are as close as possible to nature.

In choosing protection devices the following are important:

a) experience in the protection of existing installations of similar type,

b) the climatic, geographic, geologic, morphological, and biological conditions: e.g. temperatures, precipitation, wind (especially along the coast and in the presence of stationary watercourses), existing forelands or forebeaches (land or beaches outside a dike), the shape of the watercourse bed, character of the water, injurious animal or plant life,

c) the hydrological and hydraulic conditions and the possibility of influencing them structurally: e.g.

drainages, water levels and their frequency, flow with regard to magnitude and direction, tides, wave motion, effects of ship traffic, transport of solids and ice, groundwater conditions.

d) nature of the soil,

e) existing sealings,

- f) biotopic conservation and preservation of the landscape,
- g) conditions in the locality affecting the construction process, its economic feasibility, maintenance possibilities for the installations, and their effective life.

4. Construction materials

Both inanimate and living structural materials (plants) are employed. Materials producing an injurious effect upon the soil or the water may not be employed.

4.1. Inanimate structural materials

The properties, procurement, storage, processing, and structural utilization of structural materials are governed by the relevant standards, quality specifications, and permits.

The suitability of the structural materials must be judged in accordance with the particular purpose of their use. Of importance are material strength under static and dynamic loads, shape and weight, volume, permeability, composition, resistance to the attack of water or other chemical agents as well as to pest damage, resistance to corrosion, resistance to wear, resistance to weathering and aging.

4.1.1. Natural rock and synthetic rock

4.1.1.1. Natural rock (solid rock, loose rock)

The testing and selection of natural rock are governed by DIN 52100, DIN 52106, DIN 52108, DIN 52111, and DIN 52113 (further standards are in preparation). How exacting the requirements must be depends upon the stresses which are likely to be imposed on the structural material. DIN 18196 governs the grain-size range.

4.1.1.1.1. Solid rock

Especially suitable for hydraulic construction are:

Plutonic rock, compact igneous rock, sandstone, and conglomerate with siliceous binding material, compact, dense limestone, and also metamorphic rock (e.g., granolite, quartzite, amphibolite (in part), and gneiss) insofar as they are weather resistant.

Less suitable or not suitable at all are:

sandstones with clayey and calcareous binding material, material with sharp cleavages, and all rocks already subjected to heavy weathering since they display only slight longevity.

4.1.1.1.2. Loose rock

Gravels are employed as fill under subsidence rollers, wire-mesh arrangements, packed revements, etc., and as filters, with the grain size being dependent upon the hydraulic and soil-mechanical requirements.

Silt ("Schluff" = poor quality clay) and clay are of high permanency as sealants. However, their soil-mechanical properties must be checked and in using them necessary precautions must be ob-served.

Top soil (see DIN 4047 Sheet 3) is required for live construction involving standard lawn seeding (see Section 5.6.2.1.1) and grass-sod (see Section 5.6.2.1.2) as well as woodland plantings (see Section 5.6.4.2). Top soil which is contracted for should be adapted to its position; the sub-soil should be roughened. On banks attention should be given to the danger of sliding off and floating off. 4.1.1.2. Synthetic rock

4.1.1.2.1. Burnt rock

Especially suitable are clinkers KMz 350 in accordance with DIN 105 because of their resistance to frost and their resistance to wear and the attacks of water. It is assumed that they are free of cracks and are sufficiently impermeable to water.

In accordance with DIN 4051, channel clinkers satisfy severe requirements with regard to wear resistance, acid resistance, and frost resistance.

4.1.1.2.2. Concrete rock (see Section 4.1.2.2.4)

4.1.1.2.3. Slag

In accordance with DIN 4301 blast furnace slag and foundry slag are used for fill and as slag-notch rock for pavement. DIN 4226 applies to blast-furnace slag as an additive to concrete (see also Section 4.1.2.2.2).

Mortar and concrete 4.1.2.

4.1.2.1. Mortar

The composition of mortar and its properties and possible modes of application are given in DIN 1053.

4.1.2.2. Concrete, reinforced concrete, prestressed concrete

In hydraulic construction more stringent demands must be imposed with respect to water impermeability, weathering resistance, in order to avoid damage produced by moisture, temper-ature differences, and chemical or mechanical attack.¹)

4.1.2.2.1. Binding materials and concrete additives

Only officially permitted binding materials and additives may be employed. In selecting them attention must be given, inter alia, to the nature of the subsoil, the groundwater and surface water, and of other additives (see Section 4.1.2.2.2).

Refer to DIN 1164 and DIN 4030

4.1.2.2.2. Concrete additives

In this category are: natural or artificial, broken or unbroken frost-resistant additives of a composition having a porosity which is as low as possible. They must correspond to DIN 4226. The specifications are given by DIN 1045, edition of January 1972, Section 6.2.

4.1.2.2.3. Concrete-reinforcement steel and prestressed

For concrete-reinforcement steel DIN 488 is applicable, for prestressed steel the appropriate licensing regulation. Attention should be given to DIN 1045 and DIN 4227.

2.2.4. Concrete manufacture

Applicable to the manufacture of concrete, reinforced concrete, and prestressed concrete are, in particular: DIN 488, DIN 1045, DIN 1048, DIN 1084, DIN 1164, DIN 4030, DIN 4226, DIN 4227, DIN 51043, DIN 52171, and DIN 66100.

The concrete covering of steel installations must correspond to DIN 1045; in the case of waters, soils, and gases capable of attacking concrete they must be 5 cm thick.

The existing requirements apply to structural components made of locally poured concrete and to prefabricated concrete components such as concrete rock²), concrete plates, reinforcedconcrete and prestressed-concrete sheet piling, and reinforced-concrete and prestressed-concrete piling poles.

4.1.3. Bituminous materials

The suitability of bituminous materials³) depends upon the purpose of its use either as surface protection for embankments or as ground coverings or as sealing layers, upon their position either permanently under water or in variable immersion or permanently above water, upon the construction process and upon the seasonal temperature conditions during construction. Bitumen is used in protective construction primarily in the form of asphalt (mixture of bitumen and mineral materials). It may not contain any constituents which can be washed out or dissolved out by water. Refer to DIN 55946, DIN 1995, and DIN 1996.

4.1.3.1. Bitumen

For hydraulic construction distillation bitumen of the types B 200 to B 25 are especially suitable, depending upon the purpose 3).

In addition blown bitumen of types B 75/30 and B 85/25 is employed for especially high thermal stresses.

Testing according to DIN 1995.

4.1.3.2. Additives

4.1.3.2.1. Mineral constituents

Natural sand, refractory sand, fine gravel, stone chips and gravel, grain size from 0.09 to 35.5 mm. Only sufficiently hard rock should be employed. The additives must be insensitive to thermal effects occurring in the preparation of the asphalt. For suitability and a) Natural sand, testing see Section 4.1.1.1.

1) See also "Recommendations for the planning and construction of concrete bankside protective installations", Schriftenreihe der Zementindustrie, Heft 38/1971, Beton-Verlag GmbH, Düsseldorf.

- ²) See also "Note on concrete surface-covering rock in the protection of embankments", Schriftenreihe der Zementindustrie, Heft 38/1971, Beton-Verlag GmbH, Düsseldorf.
- 3) See also "Recommendations for carrying out asphalt operations in hydraulic construction", published by the Deutsche Gesellschaft für Erd- und Grundbau e. V., Essen.

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