AT THE CONSTRUCTION PROJECTS OF THE FIVE-YEAR PLAN

USE OF FILTERLESS WAVE-RESISTING REVETMENT AT THE RIGA HYDRAULIC DEVELOPMENT

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From the Editors. In publishing E. A. Lubochkov's article, the Editors draw attention to the fact that elimination of the filter layer between the concrete revetment on the upstream slope and the dam body should be substantiated in each specific case by an analysis of the stability of the upstream slope for quick reservoir drawdown, applying special measures if necessary. For instance, at the Plyavinyas dam, where such a revetment was used, soil having a large coarse-grained component was especially placed by the hydraulic-fill method. The sands placed on the upstream slope of the earth dams of the Riga hydraulic development have a permeability coefficient of up to 30 m/day, which predetermined the elimination of the inverted filter under the revetment slabs. The readers are requested by the Editors to send their observations and proposals about the problem considered in this article.

For the protection of earth slopes of hydraulic structures subjected to the action of large wind-generated waves, the use of monolithic reinforced-concrete revetments is rational. According to the current norms, inverted filters must be placed under such revetments [1, 2]. Despite the high cost of these revetments, in many cases cracks are formed and the slabs are damaged. The causes of damage may be the following:

1. The increased rigidity of the revetment slabs when they are very thick and have double reinforcement restrains their movement with differential settlement of the foundations this leads to hanging of the slabs over the hollows and to subsequent destruction under impact from large waves. At the Tsimlyansk hydraulic development, the reinforced-concrete revetment on the upstream slopes of the right- and left-bank earth dams is up to 0.6 m thick. The slabs were placed on a filter layer with strip inverted filters under the joints. Two years after filling the reservoir (1962), 10% of the revetment slabs had cracks, some of which reached widths of 5-7 cm and were traced to depths of up to 20 cm by means of a rough probe.

2. Investigations of the seepage-piping processes in the soils under the revetment slabs have shown that after filling of these soils with water and start of motion of seepage water in their pores they become deformed under wave action even in the absence of removal of any soil particles from under them. Deformation of the revetment foundations is nonuniform, as a rule, and increases when an inverted filter is placed under the slabs, since additional contact occurs between the fine-grained soil of the foundation and the coarse-grained soil of the inverted filter. The inverted filter is also deformed to a greater or lesser extent.

An adverse effect of the inverted filter under the revetment on the slab strength was observed at the earth dam for the Kremenchug hydroelectric plant during its construction in August 1960 [3]. During a major storm, waves 2.5-2.8 m high covered the uncompleted reinforced-concrete revetment, and water penetrated under the concrete slabs along the continuous inverted filter layer and eroded the fine-grained sand in the slab foundation. Subsequently, over a length of almost 1300 m, many slabs cracked or were broken. The state of the damaged slabs was indicative of the fact that the analytical scheme of slabs on an elastic foundation adopted for design did not correspond to the actual operating conditions. The crack pattern showed that the slabs operated as end-supported or cantilevered members.

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Fig. 1. Typical construction of reinforced-concrete wave-resisting revetments for wave heights of 3.0-3.5 m: 1) Filterless reinforced-concrete slabs; 2) expansion joints; 3) construction-contraction joints; 4) transition portions, at joints, of distributing reinforcement with length $l_{tr} = (1/8-1/10)L$, insulated against adherence to the slab concrete; 5) principal reinforcement, 16-30 mm in diameter, at 0.5-1.0-m spacings; 6) distributing reinforcement, 12-16 mm in diameter, at 0.5-0.7 spacings; 7) antipiping cutoff, $b_{ct} = 0.15-0.20$ m; 8) treated board at joint, $\delta = 2.5$ cm; 9) bituminous mat, plastic, or asphaltic paint applied twice; 10) bed slab (precast or cast-in-place); 11) through bars of distributing reinforcement, painted with asphalt, or special insulated short bars of length $l_{sh} = 1.2l_{tr}$.

A significant effect on the operation of wave-resisting revetments is exerted by the joints between the slabs. Especially hazardous are slip joints, in which connections between adjoining slabs are lacking. At these places, derangement of the joints and outwash of soil from the slab foundation frequently occur, which in the final analysis may also lead to damage of the revetment.

Taking into account the above-mentioned possible causes of revetment failure, the following basic criteria for design of reinforced-concrete revetments on earth slopes subjected to the action of large wind-generated waves may be proposed.

1. The reinforced-concrete slabs should have minimum rigidity and their stability should be established by large dimensions in plan and joint operation with the adjoining slabs.

2. When placing, there should be no hollows left under the slabs; this is achieved by placing cast-in-place concrete directly on the slope.

3. Inverted filters (the so-called filtering, underlying layers) should not be placed under the slabs, since they contribute to formation of hollows and loss of cement slurry during concreting of the slabs, and impair the operating conditions of the rigid revetments.

4. To control the possible formation of concentrated seepage paths and honeycomb under the slabs, antipiping cutoffs intersecting them should be constructed.