

EXPERIMENTAL INVESTIGATION OF ACTIVE HYDRODYNAMICAL METHOD REDUCTION SCOUR BRIDGE PIERS

VYSOTSKY I.S.

Postgraduate of transport building faculty of Saratov State Technical University
Polytechnicheskaya str., 77, 410054, Saratov, Russia
(Tel: +7-8452-52-58-07, e-mail: ggv@sstu.ru)

Abstract

Received by the author and considered earlier on XXIX IAHR congress the phenomenological model of a flow around the cylinder on the flat basis by a stream with shift allows to find out in the settlement way the reasons of scour near bridge pier's fundament.

With their account have been offered active hydro dynamical methods of scour reduction. According to this model numerical experiments the outline of lines of a current in a plane of symmetry in front of the cylinder (fig. 1) and in a benthonic zone at height roughness (fig. 2) has been received. Besides, settlement distribution of speeds at height of roughness Δ in returnable current much more exceed their values in not indignant current.

Assuming, that having removed the reasons break-off of a boundary layer because of a positive gradient of pressure active influence at a stream in its benthonic part, that is compulsorily changing an outline of lines of a current in front of the cylinder it is possible to reduce the sizes scour. These methods have been named "hydro active" methods.

If as an original cause of formation of local erosion to consider 3D break-off of a turbulent boundary layer in front of the cylinder which is caused by too small stock of kinetic energy at particles of the liquid, to forces of pressure insufficient for counteraction at their positive gradient. It is possible is artificial to inform particles in a boundary layer an additional stock of energy, so that, as it is known from aerodynamics, results in a tightening of break-off of a boundary layer. In our case, it would result in reduction of a zone of returnable currents and, accordingly, reduction of the sizes of whirlpool of washout.

The zone of break-off is easily visualized at coloring of jets with potassium permanganate. Earlier many researchers were communication of the area of a zone break-off with depth of is reliably established, - the earlier break-off occurs, the it is more size of a funnel larger. This simple principle allows with the help of experiences at not washed away day qualitatively to estimate influence of this or that device on reduction or, on the contrary, increase in depth of washout while change of the sizes of a break-off zone of a boundary layer.

As an object it is offered to apply the device to research as a cylindrical board which is established in a benthonic zone a little bit above a point break-off a boundary layer (fig. 3). The curvilinear board can give various corners of an inclination at various backlashes between its edge and a bottom.

It was planned to test influence of simple devices as "inflow" in a benthonic part of the cylinder, located with its riding side and having the height equal $H_1 = 0,167a$.

It was developed two variants of devices (inflows) (fig. 4):

- wedge-shaped, having the pointed form with the section which is not varying on height;
- plow shaped, having the pointed form and an inclined forward side.

The hydroactive device provides a smooth flow around a construction with a rough stream. It is submitted in variants of protection of a flooded and flood-free construction and represents by a false bottom of double curvature in a vicinity of a support.

The skilled data received at studying of serviceability of four kinds of inflow (wedge-shaped and plow shaped), allowed to receive schedules of the dependences describing their efficiency.

They testify that application of semi-active devices results in appreciable effect by three reasons: first, the break-off zone a boundary layer is reduced; second, the break-off zone area decreases; thirdly, the most subject to washout front part of the cylinder is protected from washout by presence of the device. The greatest efficiency as appeared, have wedge-shaped inflow.

Devices for washing off of a boundary layer and inflow shows us comparison of efficiency of two considered devices and, practically, they are equivalent. However by a design and convenience of installation inflow have conclusive advantage.

For a comparative estimation of serviceability of the hydro active device marks of a free surface have been measured and skilled depths at a vertical $h_{\partial K}$ were determined.

Concurrence of settlement and skilled depths as in case of quiet so and rough condition of a stream were recognized as satisfactory. Maximal divergence does not exceed 10 %.

Concurrence of superficial and ground speeds within the limits of the device also can be considered satisfactory. It allows to make a conclusion about suitability of application of a method of hydraulic calculation of the hydro active device.

Predictably, experiences have shown full disappearance of a break-off zone of a boundary layer. Rather positive moment was essential reduction of benthonic speeds in comparison with a case of a flow of the cylinder with a potential stream. In particular, in midsection of a potential flow of a stream speed makes at the cylinder two speeds of an accumulating stream ($u_M = 2u_\infty$) while in the hydroactive device the increase makes: for model 1 - superficial on 58 %, ground - on 11 %; for model 2 - superficial on 12 %, ground - on 5 %. It means, that the hydroactive device, first, protects the cylinder not only from local erosion, but from its riding side, but also from lateral erosion at a maximal speeds zone. Secondly, this implies, that the hydroactive device can be executed from enough weak material. At speed of an accumulating stream smaller than washing away, there will be no scour at all.