CHAPTER 138

PERFORMANCE OF DOLOS BLOCKS IN AN OPEN CHANNEL SITUATION

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ABSTRACT

Tests on 100 gm model dolos units on the bed of an open-channel under steady state turbulent flow reveal that the dolos unit has no inherent interlocking property that would make it preferable to ordinary armour stone of the same weight in resisting movement. However interlocking can occur when dolos units are placed on a slope since the natural angle of repose of dolos units is much greater than that of ordinary armour stone, thus accounting for the enhanced K_D of dolosse in a breakwater situation.

INTRODUCTION

Model tests were conducted to compare the stability of dolos blocks, trunk width 0.35 times the overall height and mass 100 gm (0.23 lb) with rock armour of the same density and having an identical mass of 100 gm, in a steady flow of water in an open channel. Such tests could be thought of as tests preliminary to the construction of a barrier across a tidal inlet or as tests to compare the efficiency of dolosse with that of quarrystone as protection against scour in a dam situation.

Most coastal laboratories have conducted extensive testing of both rock armour and dolos units for breakwater construction and it is generally agreed, for the same wave-height (approaching normally) and period, the same density of material and breakwater slope, that the weight of armour required for the stable-damage criteria is inversely proportional to K_D, the "hydraulic damage coefficient", which is directly related to the "shape" of the armour unit. Taking K_D as 4 for rock armour and 16 for the dolos block indicates that the latter unit can withstand a wave height $\sqrt[3]{\frac{16}{4}} = 1.58$ times that for rock. Conversely a dolos unit of 0.25 times the rock weight could withstand the same height of wave attack. It is assumed here that, for practical purposes, stability equations for rock are applicable to the dolos unit with its interlocking properties and its claimed high drag to weight coefficient and that "structural damage" is absent.

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RESULTS

With the superior behaviour of the dolos unit in an uprush and downrush wave situation one might reasonably expect that, in a free non-oscillatory current, this interlocking property could play a significant role in making the dolos unit more effective in resisting movement than an equal weight of quarrystone unit. However, a solitary unit would not behave much differently unless the drag coefficient was markedly different.

To determine whether the drag coefficients were markedly different many tests were carried out on individual dolosse and rocks in a wind tunnel and in a free stream of water. It was found experimentally that $C_d \times A$ or $C_L \times A$ where A is the projected area normal to the flow were essentially the same for a single dolos or a single rock. On the basis of these tests the effectiveness of the dolos unit is apparently entirely due to its interlocking properties.

Tests were now carried out in a tilting flume with a bed of rocks and a bed of dolosse of identical mass. With a constant flow rate the slope of the flume was gently increased so decreasing the depth over the bed and increasing the velocity.

The "wipe-out" velocity was essentially the same for both the quarrystone bed and the dolos bed. So much for interlocking in this situation! To have put in a dolos bed of 25% of the weight of a quarrystone bed - as one might have deduced from wave tests - would have meant that 25 gm dolos units would have 'wiped-out' at the same velocity as 25 gm rocks, namely, by Froude scaling, at a velocity of 0.8 times the "wipe-out" velocity for the 100 gm rock.

In an effort to discover why the dolos unit is effective as breakwater protection on a slope - usually 1:2 - but not on a horizontal bed, tests were carried out on the natural angle of repose of the rocks and the dolosse, both in air and water.

A box measuring 1 m x 0.5 m x 5 or 6 units thick was filled with either rocks or dolosse and gently vibrated on a concrete vibrating table. The box was then gradually tipped about the bottom edge. The packing angle for both rocks and dolosse was essentially the same, namely 40°. The failure angle of the rock was about 50° whereas the dolosse had an angle of repose of at least 80° - and in one remarkable test 91° (see Figure 1).

CONCLUSIONS

Thus, it may be concluded that the effectiveness of the dolos unit is not materially affected by the drag to weight ratio (which is similar to that of rock), but to its high natural angle of repose. However, this phenomenon can only be brought into play on a relatively steep slope and not on the horizontal. This would explain why dolos units are not as effective when the wave attack is

oblique (see H.R.S. Report 1T159, April 1977 by A.F. Whillock" "Stability of Dolos Blocks Under Oblique Wave Attack"), and no more effective for scour protection in a horizontal situation than an equal weight of quarrystone. One can also suggest that the steeper the breakwater slope of dolosse when attacked by normal waves the better the dolos unit appears to be. Further one can also suggest that K_D for dolosse must be a function of breakwater slope.

Figure 1 - Totally Stable up to 91°
80% of Dolos Units Stable at 93°