# New Formula for Stability of Cube Armoured Roundheads

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# NEW FORMULA FOR STABILITY OF CUBE ARMOURED ROUNDHEADS

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## INTRODUCTION

Design of armour for rubble mound breakwater roundheads constitutes in many cases a problem due to the limitation of available data and guidelines. The objective of the paper is to present the results of a comprehensive model test study on the stability of cube armoured roundheads, resulting in a new stability formula.

## MODEL TESTS

Port of La Coruña commissioned in the period 2002 to 2004 the Hydraulics and Coastal Engineering Laboratory of Department of Civil Engineering, Aalborg University, Denmark, to perform physical model tests of the stability of the cube armoured roundhead for the new port at Punta Langosteira, Spain. The tests, which were performed in a basin with multidirectional wave generators, included a parametric study of the influence of slope, radius and the mass density of the cubes as well as wave characteristics including angle of incidence.

## STABILITY FORMULA

Analyses of the test results made it possible to develop the following stability formula:

$$\frac{H_s}{\Delta \cdot D_n} = 0{,}57 \cdot e^{0{,}07 \cdot R_n} \cdot \cot^{0{,}71} \alpha \cdot D^{0{,}2} \cdot s_{op}^{0{,}4} + 2{,}08 \cdot s_{op}^{0{,}14} - 0{,}17$$

Definitions and parameter ranges are given in Table 1.

Table 1. Definitions and validity ranges of parameters.

| Parameter | Min | Max |
|---|---|---|
| $D_n$, cube side length | 40mm | 40mm |
| $\Delta = \rho_s / \rho_w - 1$ | 1.4 | 1.8 |
| $\rho_s$, cube mass density | 2.40t/m$^3$ | 2.80t/m$^3$ |
| $\rho_w$, water mass density | 1.00t/m$^3$ | 1.00t/m$^3$ |
| $R_n$, head diameter at SWL over $D_n$ | 11.75 | 19.25 |
| cot α, slope | 1.5 | 2.0 |
| $S_{op}$, wave steepness | 0.02 | 0.06 |
| D, relative number of displaced cubes in active zone | no damage | failure |

Figure 1 shows the fitting of the laboratory data to the formula for given damage levels.

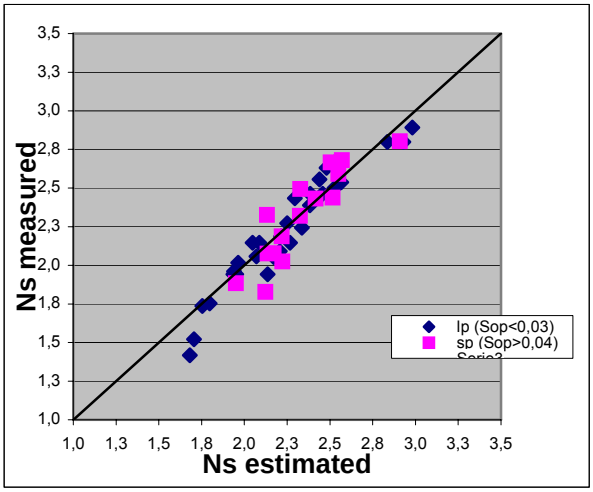


Fig.1. Fitting of laboratory data to the formula for given damage levels.

The paper provides further recommendations for head design.

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