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Director:

Rao Bahadur D. V. JOGLEKAR, B.E.

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**ANNUAL REPORT (TECHNICAL) OF
WORK DONE**

DURING THE YEAR 1945

AND

INDEX FOR 1937 TO 1945

BY

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Our experience of verification is that there is rarely enough river data available to make verification satisfactory except as a rough qualitative check, and even if there were, it would, at best, be a very slow and tedious process; because every appreciable change in one factor affects all the other factors.

Mobile river models are in fact a valuable aid to engineering skill which, however, they can never replace.

APPENDIX I

EQUIVALENT SIZE AND SPECIFIC GRAVITY OF STONES AND BLOCKS IN A MODEL.

Experiments were carried out in connection with the Sarda model.⁽¹⁾ These were more *basic* than specific in character, in that the object was to develop a technique to determine equivalent size and specific gravity of blocks and stones in models. Various grades of sand were tested to ascertain conditions

(a) when movement commenced, and

(b) when general movement developed.

The method followed consisted of laying a flat layer of loose stones and observing the depth of water when

(i) bed movement just commenced; and

(ii) general movement occurred; with different discharges.

The stone was laid in a single layer on a hard smooth bed in one series; and in a 2" layer, with similar stones upstream and downstream, but fixed to the bed in another. In the case of blocks, a single line of isolated blocks was laid across the channel in one series and a closely packed layer in another.

Fig. 123 shows results in two of the series.

Fig. 123

The following conclusions were drawn:—

(1) When (a) V^2/gd in river = V^2/gd in model,

(b) Specific gravity of blocks or stones in prototype and model are equal,

stones above 1/4" grade in a channel less than 1 ft. deep behaved *similarly* under conditions of equal V/\sqrt{gd} with diameter \propto depth; but pebbles less than 1/4" grade tended to depart from this relationship. The same was true of cubical blocks of various sizes ranging from 1/2" to 2" cube. In other words, with equal $Fr (= V^2/gd)$ in model and river, blocks and stones behave similarly when

$$\frac{\text{median diameter of stone}}{\text{depth of flow}}$$

is the same in model and river, within the limits stated.

(2) When

(a) Froude number of prototype is not equal to Froude number of model,

and (b) specific gravity of blocks or stones in river and model are equal,

⁽¹⁾Reproduced from A.R. (T), C.I. & H.R. Stn., 1939-40, pp. 50-51; also see pp. 22-23.

experiments showed that •

$$\frac{\text{median diameter of stone}}{d} \propto (V^2/gd)^{1.3}$$

Fig. 123 *approximately* for commencement of movement. Thus if the ratio of Froude numbers (model: river) is 1.2, the volume of stone in the model should be increased in the ratio, $(1.2)^{1.3 \times 3} = 2.04$ above that given by the depth scale. The index here (1.3) is, however, dependent on the velocity distribution upstream and on the similarity in shape of stones. With similar velocity distribution and shape of stone, the index would be 1.0. This also holds in the case of blocks (see 3 below).

(3) In the case of isolated concrete blocks

$$\frac{\text{Diameter}}{\text{depth of flow}} \propto (\text{Froude No.})^{0.1}$$

(4) When

(a) Froude No. of prototype is not equal to Froude No. of model,

(b) specific gravity of model and prototype blocks are also different,

$$\frac{\text{dia.}}{d} \propto \left(Fr \times \frac{\rho}{\delta - \rho} \right)^{0.1}$$

Fig. 123

where

d = depth of flow

ρ = density of water

δ = density of blocks.

As an example, supposing it is desired to reproduce concrete blocks in a vertically-exaggerated model to a similar scale than the depth scale, then the density of the material to be used is given by

$$\frac{\delta - \rho}{\rho} \propto \frac{V^2 \cdot d^{0.10}}{(\text{dia.})^{1.1}}$$

or

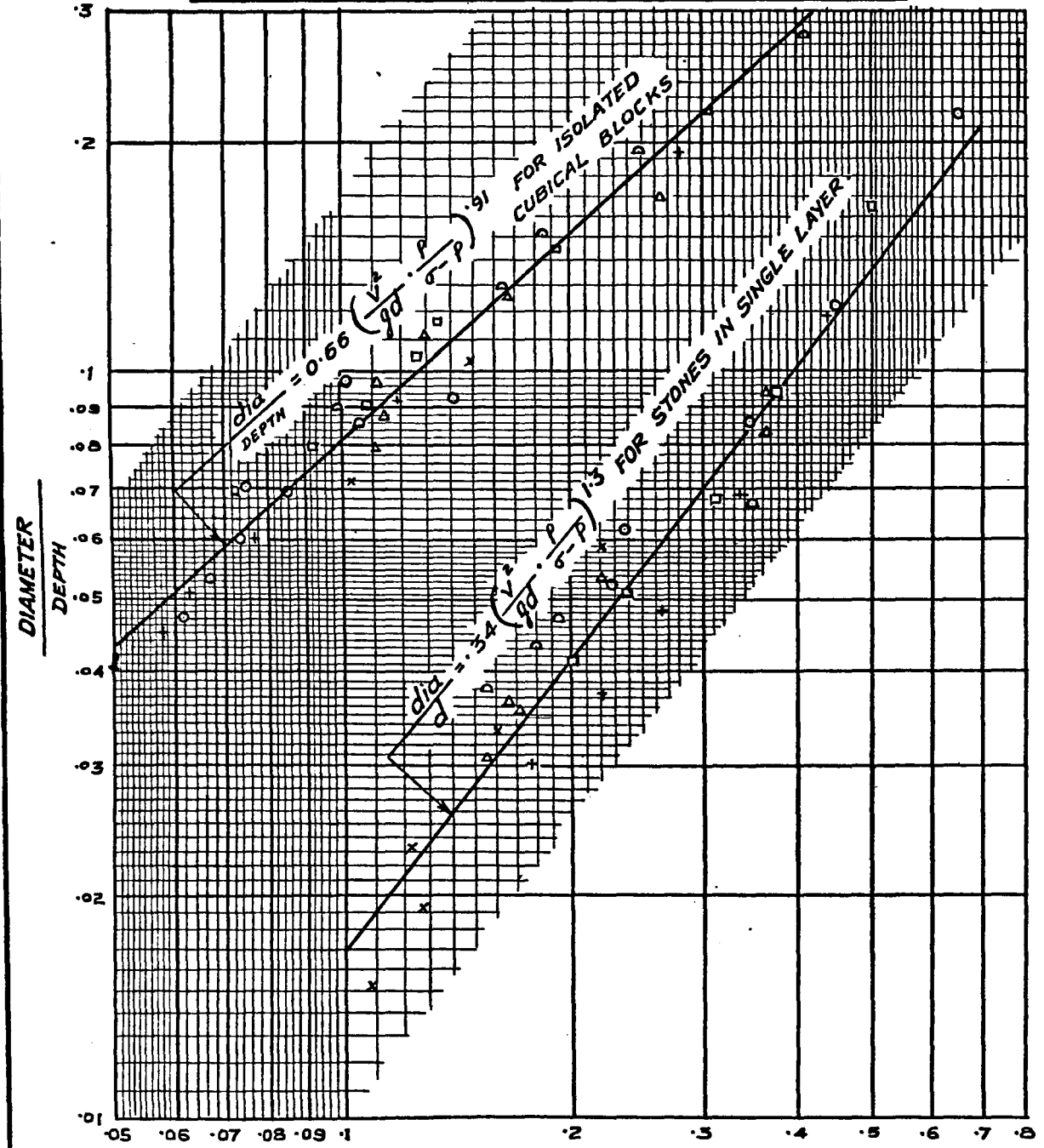
$$\frac{\delta_m - \rho}{\delta_p - \rho} = (V_m/V_p)^2 \times \left(\frac{\text{dia. p}}{\text{dia. m.}} \right)^{1.10} (d_m/d_p)^{0.10}$$

where the suffixes m and p refer to model and prototype respectively.

FIG. 123

EXPTS. WITH STONES AND BLOCKS
CONDITIONS FOR INITIAL MOVEMENT OF STONES
IN SINGLE LAYER & ISOLATED CUBICAL BLOCKS.

| | CUBICAL BLOCKS | | STONES | |
|---|----------------------------|---------|-------------------------|---------|
| | SIZE OF BLOCKS IN FEET. | SP. GR. | MEDIAN DIA. IN FEET. | SP. GR. |
| x | .043 | 2.16 | .0141 | 2.9 |
| + | " | 2.39 | .0229 | " |
| o | " | 3.61 | .0303 | " |
| □ | .083 | 2.44 | .0273 | " |
| △ | " | 2.28 | .0303 | " |
| △ | " | 2.14 | .0369 | " |



$$\frac{V^2}{gd(\sigma - \rho)}$$

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