研　究　速　報

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FUNDAMENTAL STUDY ON THE EFFECT OF JETTED WATER IN SEABED SOIL

水噴射型貫入装置の基礎的研究（第2報）

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1. Summary

Lower cost and greater efficiency in excavating the seabed for underwater cables can be obtained by jetting water into the ground and fluidizing the seabed soil under operation. However, little research has been conducted on this topic. In order to estimate the optimum volume of the jetted water, it is essential to examine the relationship between speed of jet and the limit of the fluidized area.

This report proposes a practical formula to determine the volume of the fluidized soil for variable jetted water volumes under a variety of seabed conditions.

2. Characters of the Fluidized Area

Fig.1 is a schematic arrangement of the apparatus used for the two dimensional experiment. Water drawn from a tank is jetted at velocity V into the sand through a slit on the wall of a cartridge tank. The sand box, 800mm in depth, 450mm in breadth and 200mm in length, is made of transparent acrylic boards. The movement of sand in front of the slit is filmed with a 35mm camera. The distribution of the particle size of the four kinds of the sand is shown in Fig.2.

In the vicinity of the slit, the sand particles flow rapidly under the pressure of the jetted water (cf. Fig.3). This flow area is denoted as the fluidized area and can be clearly distinguished from the surrounding sand. On the basis of these experiments, this area can be divided into two sub-areas (A and B) ; in sub-area A, the sand flows very rapidly as viscous material, and in sub-area B, the sand slides down due to plastic failure. The sand

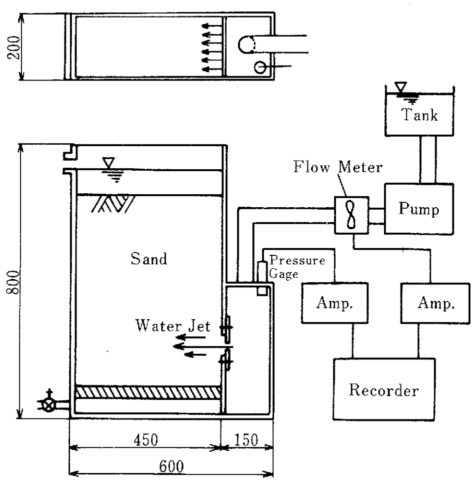

Fig.1 Schematic arrangement of the apparatus

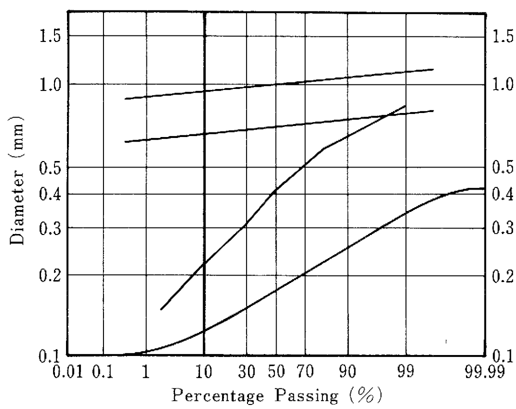

Fig.2 Distribution of sand particle size

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particles in A with large void ratio are carried upwards while the sand particles from sub-area B are fed into area A. This creates a steady state phenomena. The expansion of area A in front of the slit is represented by the distance L as illustrated in Fig.3. In this report, L is defined as the "fluidized length".

Fig.4 shows examples of configuration of the limit for the fluidized area. With the series of experiments, it is shown that the configuration of this area in front of the slit does not depend upon the depth of slit from the surface of sand but the velocity of jet. It should be noted that to maintain the same speed of jet, the water head supplied must be increased for greater depth.

Fig.5 shows the relationship between the fluidized length L and the velocity of the jet V. As shown in Figs.6 and 7, the gradient dL/dV is also regarded as proportional to the square of the slit gauge d and the square of effective grain size D_{10}.

On the basis of these results, L/d (the non-dimensional value of the fluidized length) can be represented by the Floude Number $V/\sqrt{gd}$ (based

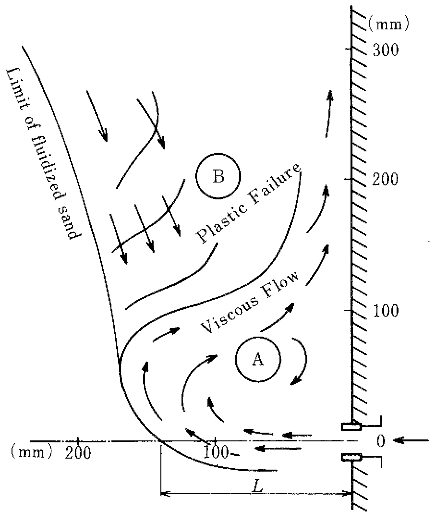

Fig.3 Movement of sand in the fluidized area

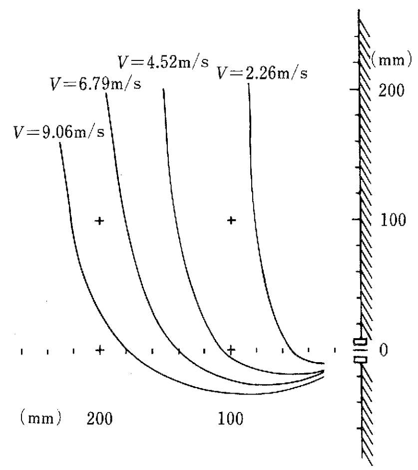

Fig.4 Configuration of the limit for the fluidized area (d=0.5mm)

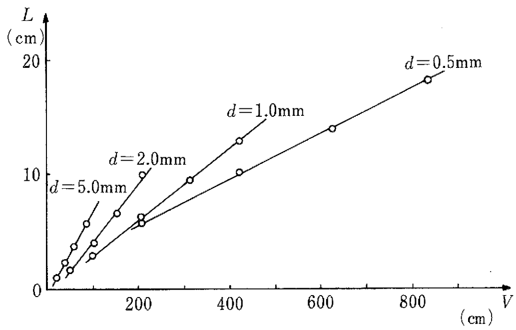

Fig.5 Relation between dL/dV and d (D_{10}=0.22mm)

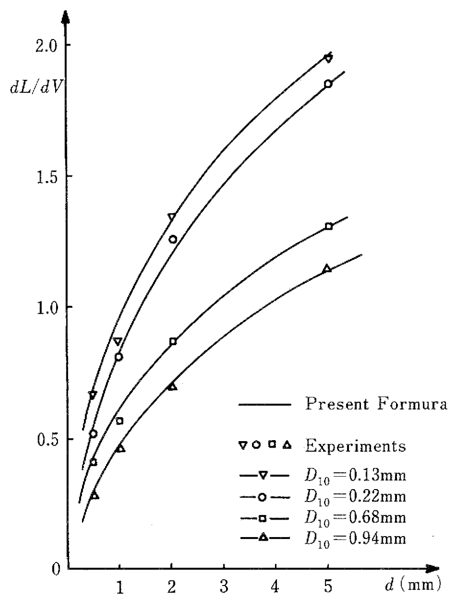

Fig.6 Relation between dL/dV and d

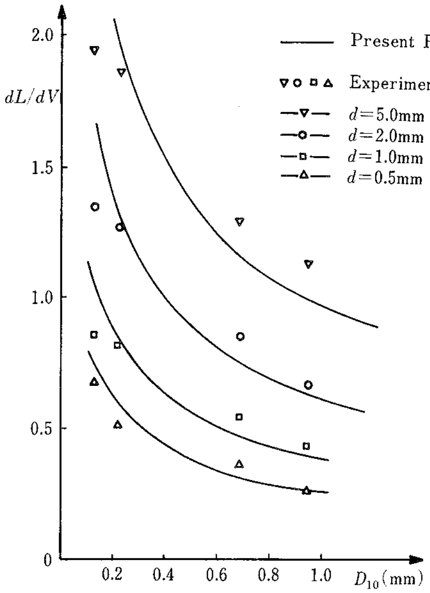

Fig.7 Relation between dL/dV and D_{10}

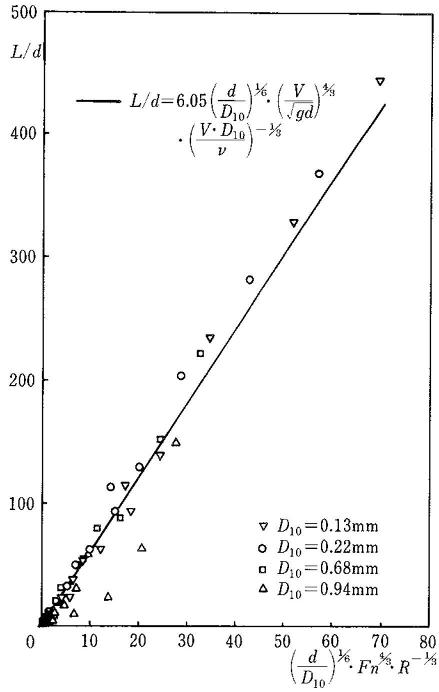

Fig.8 Empirical equation for fluidized Length L

on the slit gauge) and the Reynolds Number VD_{10}/ν (based on the effective size of sand and the coefficient of kinematic viscosity) as follows;

$$L/d = K(d/D_{10})^{1/6} Fn^{4/3} Re^{-1/3}, \quad (1)$$

$$Fn = V/\sqrt{gd}. \quad (2)$$

$$Re = VD_{10}/v. \quad (3)$$

The coefficient K of Eq. (1) is determined on the basis of experimental data shown in Fig.8 as

$$K=6.05 \quad (4)$$

3. Discussion

The configuration of the fluidized area produced by water jetted into the sand can be estimated using the empirical Eq. (1). It is possible to take into account of the effect of sand properties by use of the Reynolds Number defined by Eq. (3). The effect of sand density is disregarded as it is almost same.

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References

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