9. A DISTINCT IMPROVEMENT OF THE MEDIUM-SPEED CIRCULATING WATER CHANNEL

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In Japan a study group on a circulating water channel was organized in November 196I, and since then the group has been working continuously improving the performance of the water channel and also developing its usage.

It is essential requirement of the free surface water channel that the velocity distribution in the working section should be uniform with depth, particularly near the free surface, and recently it has been clarified that the wave-breaking phenomenon at the bow assumes quite different patterns according to the velocity distribution near the surface, which may also stress the need of the velocity uniformity.

At the latest meeting of the group R. Ogura, S. Matsui et al (West Japan Fluid Engineering Laboratory, Co., Ltd.) presented an ingenious design of the medium-speed circulating water channel to be used for ship model testing. The design has two features; one is a new surface accelerating device and the other is the adoption of plural impellers. The channel based on their design achieved excellent results in points of a uniform velocity distribution near the surface and a less obliquity of the flow along the working section.

The channel shown schematically in Fig.I has a working section 2.0 m (6.6 ft) wide, I.0 m (3.3 ft) deep and 5.0 m (I6.3 ft) long, with a capacity of 70 t circulated by two impellers each driven by a I5 kw (20 hp) motor. The water velocity in the working section can be controlled over the whole range from 0.07 to 2.05 m/s (0.23 to 6.7 ft/s). For the lowest speed range between 0.07 and 0.I5 m/s one motor is used.

The width-depth ratio of the working section of the channel is preferable to be two or more as that of a conventional tank. In order to have a uniform velocity across the oblong cross section, plural impellers arranged side by side surely do better than one impeller does. Provided with two impellers for the 2:I oblong working section the nozzle of the water channel is contracted uni-directionally both at the top and bottom walls with the ratio of 2.3:I, while most of the water channels is contracted bi-directionally.

There would be the boundary-layer growth on the upper surface of the nozzle which would produce significant velocity deficit over a small depth near the free surface. Various methods of dealing with this wake problem, including boundary-layer suction, jet injection and a paddle wheel or rotor, were proposed and tried, and none of them proved to be satisfactory. The new method introduced by Matsui to reenergize the wake at the end of the nozzle consists of three components, a rotor, its casing filled with water and a splash cutting and suppressing plate. Schematic diagrams for his method together with its preceding ones are shown in Fig.2. The rotor speed control is coupled into the main speed control of the channel so that the acceleration of the boundary-layer would be set correctly at all channel water speeds. The velocity profiles near the surface by three types are shown in Fig.3. Fig.4 shows the velocity profiles at four depths breadth-wise in the working section. The deviation from the mean velocity of I.0 m/s is as low as I.0 per cent with Type 3. A beneficial side effect of the new system is that the free surface is made considerably smoother, and the double amplitude of the standing wave and that of the free surface are as small as 2 mm and I mm respectively.

The resistance tests results in the water channel, corrected for the blockage effect due to the restricted waterway and for the surface gradient, substantially agree with those in a towing tank as shown in Fig.5. Further study is undertaken of the rotor for a high-speed water channel.

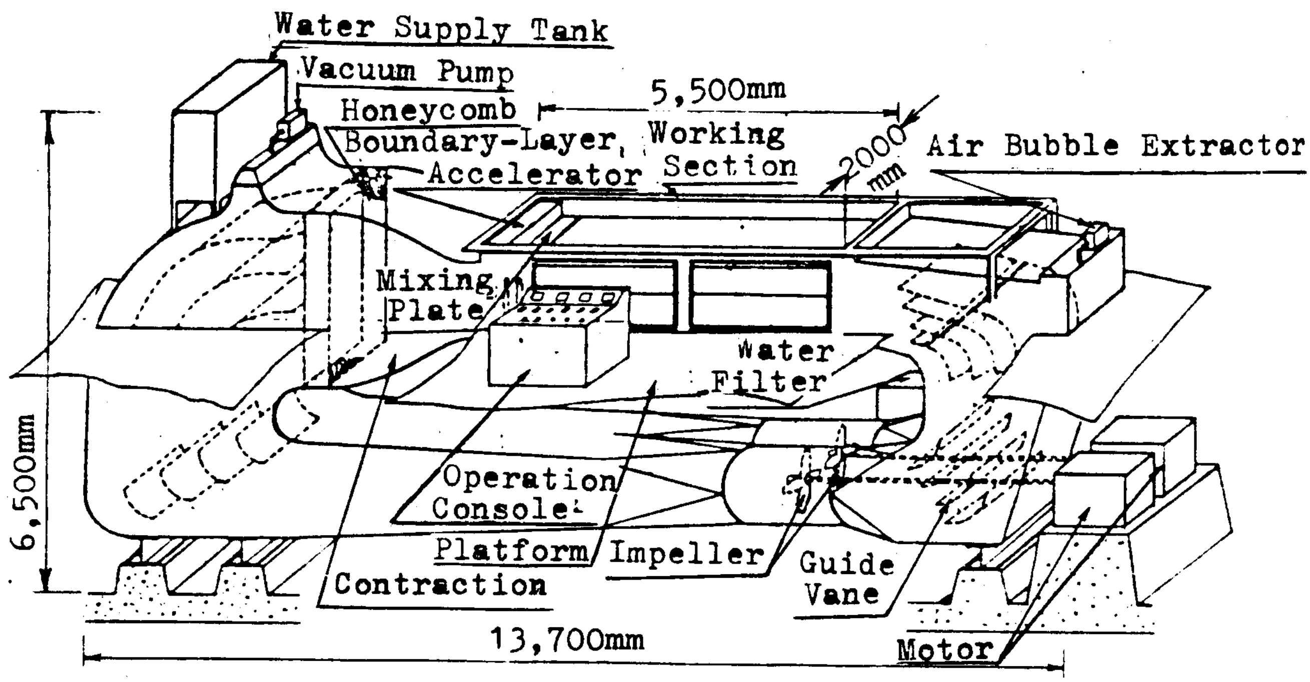

Fig.1 Schematic diagram of the new recirculating water channel

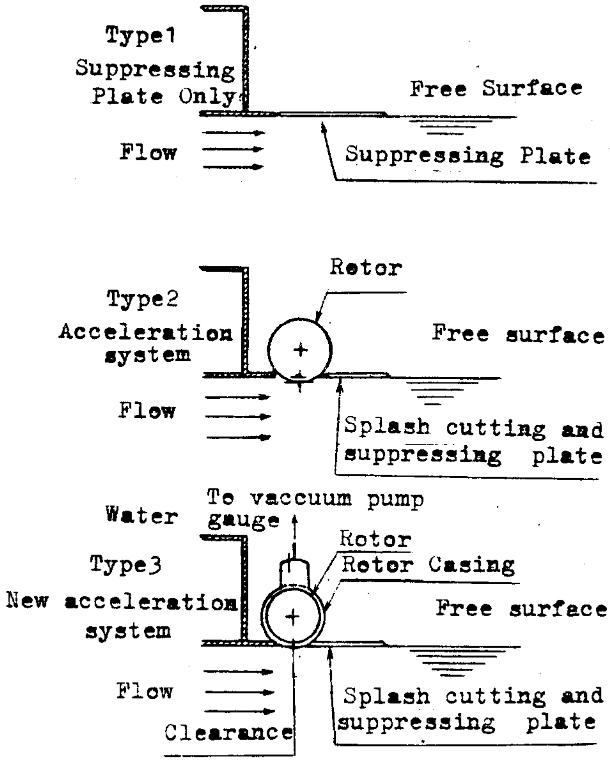

Fig.2 Schematic diagram of boundary-lay accelerator systems

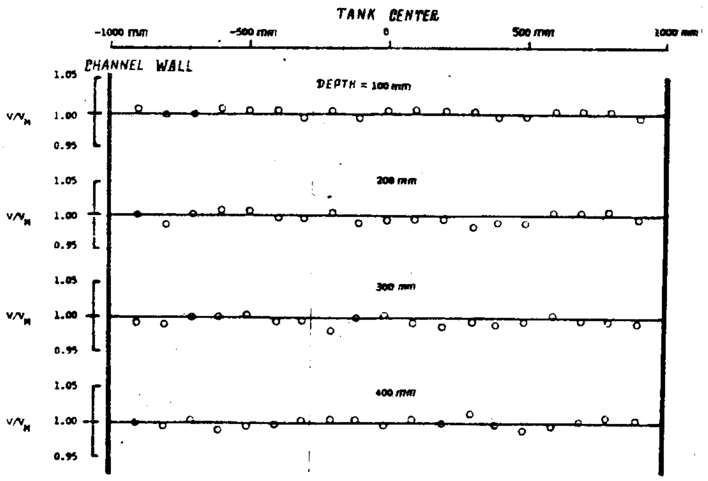

Fig.4 Velocity distribution breadth wise at the working section(V_M: mean velocity)

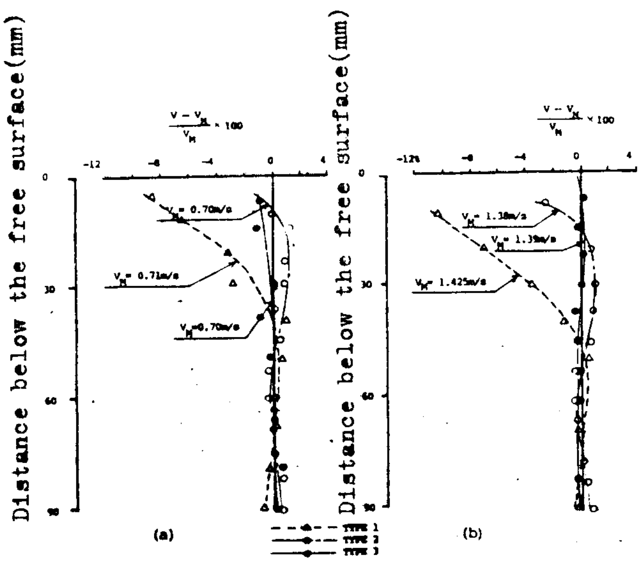

Fig.3 Velocity distribution on the centerline of the working section with three types of the systems to make good the momentum deficit

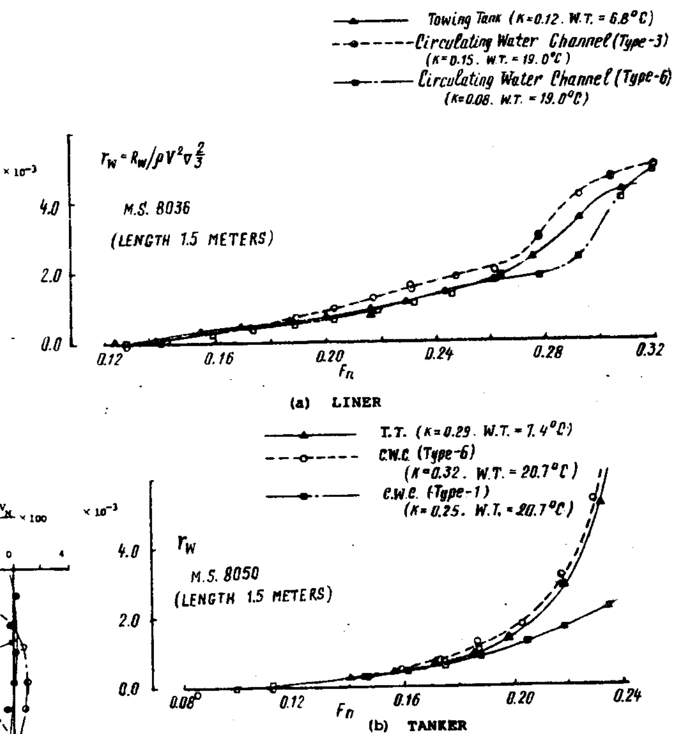

Fig.5 Comparison of wave-making resistance coefficients