Session on

INVESTIGATIONS OF FREE-SURFACE PHENOMENA

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INTRODUCTORY REMARKS

The phenomena occurring at the free surface of water when the water moves at high velocities through relatively still air or the air moves over relatively still water are fascinating to observe but are difficult to analyze quantitively. The "white water" which is seen when water flows over high spillways and dams or down steep chutes is quite spectacular, but the engineer who must take such air entrainment phenomena into account in his designs has very little information of a factual nature to use.

Surface disturbances and air entrainment produce considerable difficulty in laboratory apparatus which involves the use of high speed, free surface flow. The difficulty in maintaining a relatively smooth water surface has been one of the chief deterrents in utilizing moving water for tests on surface craft. However, the David Taylor Model Basin of the U.S. Navy realizing the many advantages of having an open-channel test apparatus for their various problems has succeeded in perfecting a re-circulating channel for operation at water speeds up to about 20 ft. per sec. This unique equipment presented numerous hydraulic problems in its design, and these problems are discussed in detail by Lt. Charles A. Lee who was in charge of the development of this equipment under the direction of Captain H. E. Saunders, Director of the Model Basin. Lt. Lee graduated from the University of Wyoming in 1939 and received a Master of Science degree in hydraulics at Lehigh University in 1940. During the war he was in the Navy Construction Battalions in the Southwest Pacific.

Unfortunately surface air entrainment cannot be studied by use of any known model relationships. Thus the investigator is forced to make his observations on full scale structures. Such field observations have been made by Mr. L. Standish Hall who is Principal Hydraulic Engineer, East Bay Municipal Utility District, Oakland, California. In his paper Mr. Hall analyzes a large amount of data which he has obtained on a number of steep chutes and spillways in the West. His analyses and observations form an important step in the understanding of a complicated hydraulic phenomenon and the relationships he presents should be of use in future designs.

Closely related to the problem of air entrainment by high-velocity flow in steep chutes is that of the breaking up of water jets such as those issuing from fire nozzles. Observations on air entrainment by high-velocity water have definitely indicated that the turbulence in the water is an important factor influencing the surface breakup and entrainment of air. Thus the elimination or decrease in turbulence should decrease the tendency toward dispersion of highspeed jets of water. This is of considerable importance in fire jets when a localized concentration of water is desirable. Professors J. W. Howe and C. J. Posey, Research Engineers of the Iowa Institute of Hydraulic Research, have had charge of a research project, sponsored by the David Taylor Model Basin of the U.S. Navy. at the request of the U.S. Coast Guard, on the improvement of the streams issuing from fire nozzles. They have obtained very worthwhile data which point to the fact that present fire nozzle designs may be improved from the standpoint of providing less turbulent streams. Their paper which gives some of their preliminary results should prove of considerable interest to all hydraulie engineers, as it points the way in which a practical hydraulie problem can be successfully attacked by the use of some of the newer concepts in fluid mechanics.