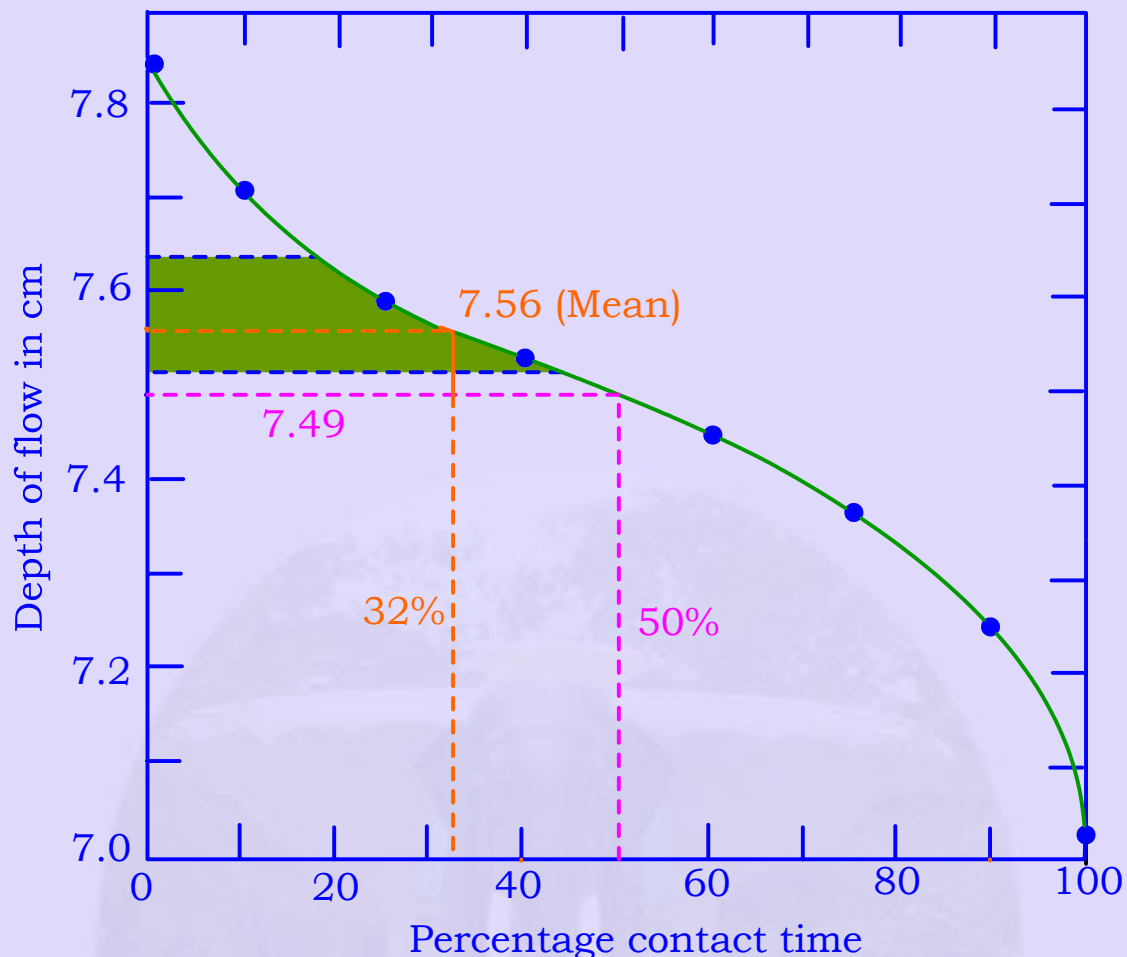


4.5 Errors in Depth Measurement in high velocity flows in laboratory using Point Gauges: (Jayaraman and Sethuraman, 1973)

Water depth measurements in high-velocity flow in open channels are subject to inaccuracies due to the presence of surface pulsations that are a characteristic feature of super critical flows. Since the depths of water in supercritical flow in laboratory channels are usually small, the importance of accurate depth measurement cannot be overemphasized.

The most common device for measuring the depth of a supercritical flow in a laboratory flume still continues to be the good-old point-gauge. Although more sophisticated electrical probes are available for depth measurement, these invariably give rise to flow-disturbance when immersed in a high velocity channel-flow. In order to improve the accuracy of point-gauge measurement, Brock suggested the provision of pressure taps on the bed of the flume and a visual check of the tip of the point gauge at a depth setting corresponding to the mean hydro static pressure indicated by the pressure cell. This method evidently cannot be applied for plotting surface profiles, as in transitions, where a large number of depth measurements scattered all over the flume may be necessary. Moreover, the assumption that the mean pressure indicated by the pressure cell corresponds to the hydrostatic pressure for the mean depth needs experimental verification in view of the unknown dynamic effects of the water surface pulsations.

A simple and inexpensive instrument, the Gauge Contact-Time Indicator that can be used with any point-gauge to improve the accuracy of depth measurement.



Water level fluctuations at Froude Number equal to 3.5 (after Jayaraman and Sethuraman)

Figure shows an experimental plot of the gauge reading (with the channel bed as datum) versus percentage contact time at a Froude number of 3.5.

Repeated tests made by more than one observer showed that for a specified contact time of 50%, the gauge readings could be repeated to an accuracy of ± 0.1 mm, even though the water surface had pulsations of about 8 mm amplitude.

The following conclusions are drawn regarding the use of the Contact Time Indicator for point-gauge measurement in high-velocity flows:

1. Point-gauge measurement in high-velocity flows by visual observation of the tip of the gauge inevitably involves a positive error in the measured depth of flow. This error can be serious when the flow-depth is very small as is often the case in the study of supercritical flow through channel expansions.
2. By specifying a particular contact time - say 50% - the technique of depth measurement using the point -gauge can be refined and standardized. Errors due to

persistence of vision, that are present in a visual observation of the tip of the gauge, are eliminated.

3. The use of the Contact Time Indicator eliminates the "personal error" inherent in point-gauge measurement in high velocity-flows. With this instrument, all observers can get readings within ± 0.01 cm.

4. Where a large number of depth observations are to be made in a single test-run, such as in the plotting of surface profiles in supercritical transitions, the instrument reduces considerably visual fatigue of the observer. The observer need not even look at the water surface while making depth observations.

Reference:

R. JAYARAMAN and V. SETHURAMAN "IMPROVING THE ACCURACY OF POINT-GAUGE MEASUREMENT IN HIGH-VELOCITY FLOWS", Journal of Hydraulic Research, Volume 11, Number 4, 1973, Page Number 317 to 323.

