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Effect of Inlet Angle from Tributary into Main Channel

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Introduction

Open channel flows play a significant role within major metropolitan areas in the removal of excess surface runoff. Main channels are responsible for the removal of all excess surface runoff which are fed by connecting tributaries. Both main channels and tributaries can occur naturally or be man-made but their orientation must be considered in the removal of excess surface run off. It is believed that the angle in which the tributaries connect to the main channel is an important factor in whether the run off is removed efficiently or a major contributor to flooding.

Current practice requires tributaries in flood control channels to enter at small angles to avoid disrupting flow in the main channel and impacting channel capacity. These small angles are costly to construct and their value is questionable, especially when tributary flow is small compared to the main channel capacity. This is often the case, especially for smaller tributaries and conduits. There is a need to evaluate the impact of tributary discharges into open channels across a range of flow rates, velocities, and entrance angles.

Area of Study

The watershed in the Las Vegas Valley all drains into Lake Mead which is part of the Colorado River system. The primary route all the water takes to get to Lake Mead is through the Las Vegas Wash and its tributaries. There are ten tributaries that flow into Las Vegas Wash and these tributaries are Las Vegas Creek, Red Rock Wash, Flamingo Wash, Tropicana Wash, Duck Creek, C1 Channel, Sloan Channel, Range Wash, Monson Channel, and Tropicana Ave Floodway. Las Vegas has one of the fastest growing populations the nation averaging about 127 new residents per day. With the increase in population, there is also an accompanying increase in urban development. The more urban development there is, there becomes less places for storm water to go into the ground which leads to more surface run-off. Knowing these facts, it is important to have the Las Vegas Wash capable of removing this excess run-off at its maximum capacity in order to prevent flooding.

Method

The primary tool that will be used is the flume located in the fluids lab at UNLV's college of engineering. A flume is an artificial channel which has a stream of water running through it. The water in the flume is supplied by a sump pump in which the same water is circulated through it depending on the flow rate set through the flume.

It will be necessary to obtain supercritical flows in the flume to mimic potential flood flows in CCRFCD channels. This may require the flume to be narrowed or additional pumping capacity to get a reasonable water depth while maintaining a supercritical flow an inlet pipe will be installed through the flume wall to provide the tributary channel flow. Flow through the inlet will be provided through a separate variable-speed pump fed by water from the flume sump. The separate flow controls will allow the ability to precisely deliver flow combinations required in the testing matrix. The inlet connection will either allow for a range of angles or different inlets will be constructed at different angles.

	Flow Proportion (Main:Tributary)				
Inlet Angle	25:1	20:1	15:1	10:1	5:1
90	x	x	x	x	x
75	x	x	x	x	x
60	x	x	x	x	x
45	x	x	x	x	x
30	x	x	x	x	x
15	x	x	x	x	x

Previous Study

James Best and Ian Reid conducted similar research observing the separation zone that develops downstream from the tributary entry into the main stream. The separation zone is the zone where the tributary flow detaches itself from the side wall and there is lower pressure and water that recirculates.

The test was conducted by the use of a flume that was constructed to handle four different junction angles ranging from 15 degrees to 90 degrees. Flow is discharged separately in both channels in order to adjust flow ratios. The shape and size of the separation zone was observable by the use of photography of surface dye traces.

Conclusions

Unfortunately, there are no results at this time. The experiments were not conducted as planned due to problems with the flume and the system fluid circulation. Currently no flow can get to the flume. The problem should be corrected in the near future but the exact time frame is not known.

Had the experiment been conducted, expected findings would be based off the previous experiments similar to this experiment and just having a feel for basic physics. It is expected that at larger junction angles, the upstream depth in the main channel would rise higher when compared to smaller junction angles. It is also estimated that with a decrease in main channel to tributary channel ratio, the depth in the main channel will increase and decrease as the ratio is increased. An angle of 15 degrees with a discharge ratio of 25:1, should produce the smallest depth increase if any increase at all. A junction angle of 90 degrees having a discharge ratio of 5:1 should produce the most pronounced depth change.

References

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