Celerity and Attenuation/Amplification of Supercritical Flow Waves

Noah I. Friesen[1]
Department of Civil and Environmental Engineering, Colorado State University, Fort Collins, CO.

Jennifer G. Duan
Department of Civil Engineering and Engineering Mechanics, University of Arizona, Tucson, AZ.

Pierre Y. Julien
Department of Civil and Environmental Engineering, Colorado State University, Fort Collins, CO.

Abstract. Supercritical flow waves often occur in steep open channels. This study investigates the celerity and attenuation/amplification of supercritical flow using the dynamic wave approximation. Assuming uniform base flow, analytical results show that flood waves amplify when the Froude numbers are greater than 1.5 and attenuate when the Froude numbers are less than 1.5. Flood waves with a Froude number equal to 1.5 maintain the same amplitude as they propagate downstream. This supercritical wave amplification has significant implications for channel design. Freeboard above the design flow depth must be sufficient to contain the amplified waves.

The theoretical results were applied to the F1 channel in the Las Vegas Valley. It was found that dimensionless celerity tended to increase with flow rate for short waves (100m or less). The maximum wave amplification occurred for waves between 500 and 1000 m long, and was dependant on wavelength and flow rate.

Further investigation was done on lateral inflow into the F1 channel. Dimensionless celerity was found to increase as inflow increased except for very low flows. For small and medium wavelengths, the attenuation factor decreased relatively uniformly as flow increased. This result indicates that flow from a storm drain or small lateral channel can reduce the amplification of waves in the main channel.

[1] Department of Civil and Environmental Engineering
Colorado State University
Fort Collins, CO 80523
Tel: (970) 420-5770
e-mail: arkf@engr.colostate.edu