A BASELINE STUDY OF THE EFFECT OF FRESHWATER BIOFILMS IN HYDRAULIC CONDUITS

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The carrying capacity of hydraulic conduits is known to deteriorate over time due to the growth of biological material on internal surfaces. The friction and roughness effects of these growths on the flow are not well understood. Schultz (1999) found the equivalent sandgrain roughness height of biofilms to exceed the physical height. This problem of biological fouling (biofouling) can afflict most types of hydraulic conduits, be they for water supply (Brown 1903-1904; Minkus 1954), drainage (Bland *et al.* 1975; Perkins and Gardiner 1985) or hydro-electric power generation (Barton *et al.* 2004; Brett 1980; Picologlou *et al.* 1980; Pollard and House 1959).

A multi-faceted program is underway at the University of Tasmania investigating ways to control biofouling in hydraulic conduits and to conduct fundamental research on the roughness and friction characteristics of freshwater biofilms. Biofilms differ from standard engineering materials as they have complex topographies and visco-elastic properties. A multidisciplinary approach has been applied to the research program with aspects including paint trials to see which have an ability to prevent or minimise biological growth (not unlike anti-fouling paints used in the shipping industry, though more environmentally appropriate) using a variety of paint types in different flow conditions in both pipes and canals; field studies investigating the headloss of biofouled and cleaned conduits and determining the respective friction factors and equivalent sandgrain roughness for comparison; microbiological studies investigating biofilm communities, diversity and possible methods to control their development; an experimental laboratory program using a newly built water tunnel to investigate the friction and roughness characteristics of biofilms in a controlled way; and an innovative photogrammetry program using close range techniques to map the three-dimensional physical surface of biofilms.

This paper a presents a baseline study of total drag measurements and boundary layer velocity profiles of a specially prepared test plate to determine the plate roughness characteristics. Experimental measurements from the water tunnel are compared to three-dimensional physical roughness data obtained from close range photogrammetric methods. The broad aim of this research is to determine, in the first instance, how well the measured three-dimensional roughness data (with fundamental data reduction) compares to the roughness effects measured in the water tunnel. Later in the research program test plates with biofilms at various states of maturity and hydraulic conditioning (i.e. grown in the field in predominantly high or low velocity regions) will be studied in this manner.

Results presented in this paper show that the methods used to determine the equivalent sandgrain roughness of the test plate with non-uniform sandgrain type roughness agree to within 20% with the photogrammetric data. These information and measurement techniques will enable optimization of conduit performance and maintenance, minimise the effects of biological growth and increase the economic return from existing hydraulic infrastructure.

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