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Optimal design of composite channels using classical methods and genetic algorithm

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Manmade channels are the life-line of the agricultural sector of any country. They are used for carrying water from dams and other storage structures to the fields for irrigation purposes and to the cities for distribution after treatment. The channels can be either lined with brick, concrete, grass, and other suitable material or unlined (earthen). The shape of the manmade channels is usually trapezoidal although semi-circular and parabolic shapes are also in use. Many times the different sides of a trapezoidal channel need to be lined with a different material due to certain site conditions. A channel with different roughness on different parts of its cross-section is called a composite channel. The design of composite channels is a complex problem and traditionally design monographs are used by the practicing engineers. Such design procedures routinely result in over-designed sections leading to increased costs of construction. With the availability of fast computers and robust optimization methods as genetic algorithm, it has become possible to design composite channels optimally with minimum costs.

In the design of composite channels, the main problem is the use of the equivalent roughness coefficient in the design procedures. This paper presents the results of a study aimed at evaluating the effects of using different equivalent roughness coefficient formulae on the optimal design of a composite trapezoidal channel section using genetic algorithm. Classical optimization problem solution techniques are also used for comparison purposes. The optimization problem consists of the excavation and lining costs as the objective function to be minimized and the Manning's equation of uniform turbulent flow as the constraint. It has been found that different equivalent roughness coefficient formulae result in different optimal designs of composite sections. A new approach of accounting for the changes in roughness coefficient along the wetted perimeter is also presented. The new approach of accounting for the spatial variations in the roughness coefficient along the wetted perimeter resulted in significant savings in the construction costs of the composite channel.