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# Analytical and laboratory modelling of granular filters for embankment dams

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# ANALYTICAL AND LABORATORY MODELLING OF GRANULAR FILTERS FOR EMBANKMENT DAMS

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By

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# DECLARATION

I, Mark Locke, declare that this thesis, submitted in fulfillment of the requirements for the award of Doctor of Philosophy, in the Faculty of Engineering, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

Mark Locke

September 20, 2001

# SUMMARY

Granular filters are used in embankment dams to protect the dam core material from internal erosion, while draining seepage water to prevent saturation of the downstream embankment. In this thesis, a mathematical model is developed to describe the time-dependent processes of filtration of non-cohesive base soils, modelling the rate of erosion and transport of particles into the filter. As particles are captured within the filter, they in-turn are able to retain progressively finer base soil particles until a self-filtration zone forms that is able to prevent any further erosion. The model predictions are verified with a series of laboratory tests in newly constructed, large scale filtration equipment, the largest of its kind in Australia.

Erosion and filtration of a crack through a cohesive dam core is described by analytical modelling. The processes of erosion of the crack walls, transport of particles through the crack, and capture of the particles within the filter are combined to produce a time-dependent model describing the sealing of a cracked core as a filter cake forms. The model is able to predict crack erosion for various filters and hydraulic conditions, and has been applied to several case studies to identify practical uses of the model.

Extensive laboratory work examining erosion and filtration of cohesive base soils provides an improved understanding of the filtration process. Particles eroded from the walls of a pinhole were shown to be coarser than the original base soil particles, and these coarser particles influence filtration. Based on the experimental data, a new design procedure for broadly graded base soils, called the Reduced PSD method, is developed.

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*What did the fish say when it bumped into a wall? Dam.*
(Janet Locke, 2000)

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