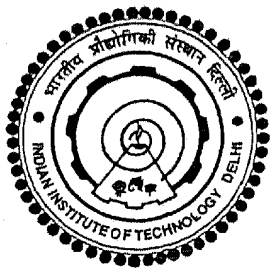
TANK AND ANICUT IRRIGATION SYSTEMS: AN ENGINEERING ANALYSIS

CHITRA KRISHNAN
Department of Applied Mechanics

Submitted
in fulfillment of the requirements for the degree of
DOCTOR OF PHILOSOPHY

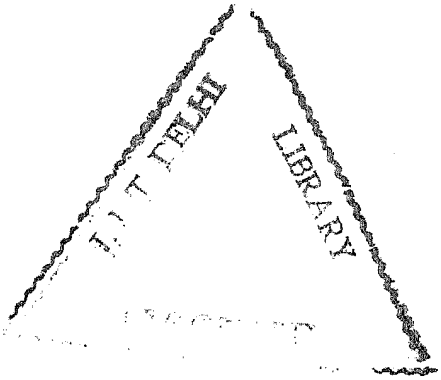
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those

who walk this way

and find themselves asking similar questions.

CERTIFICATE

This is to certify that the thesis entitled "**Tank and Anicut Irrigation Systems: An Engineering Analysis**", being submitted by **Chitra Krishnan**, to the Indian Institute of Technology, Delhi for the award of the degree of **Doctor of Philosophy**, is a record of bonafide research work carried out by her. Chitra Krishnan has worked under our guidance and supervision in conformity with the rules and regulations of Indian Institute of Technology, Delhi.

The research report and results presented in this thesis have not been submitted, in part or in full, to any other university or institute for the award of any degree or diploma.

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Getting the mobile bed experiments started was particularly problematic and took months. The timely appearance of Arjun made all the difference. He was eminently suitable with his keen interest and initiative and we were able to run the first few mobile bed expts. Each expt. took 50 to 60 hours continuously and would have been impossible but for my friend Alok's support who organised his work timings so as to give me breaks during the runs. He was the proverbial 'friend in need is a friend indeed' and special thanks to him. The final set of mobile bed experiments were possible only because Narinder, Roop Lal, Ramar and Brij Mohan took turns to help with the day and night shifts.

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Chitra Krishnan

ABSTRACT

The *Tank and Anicut* irrigation system of South India dates back a thousand years. This study is a first step in conducting an engineering analysis of this traditional irrigation system – specifically, the methods inherent in this system to deal with sediment problems. To the best of our knowledge a serious attempt with the above objective has not been made before.

Tanks are earthen water reservoirs while *anicuts* are weirs built across rivers. Tanks were rarely isolated, instead a series of tanks in a network or chain was common. Some of these networks were fed by an anicut diverting water from a river. Given the scant existing knowledge sources for studying this subject, the methodology adopted was to carefully study a few examples with a view to uncover general principles.

In the case of anicuts the focus was on the behaviour of bed sediment transport effects. The problem of excessive sediment entry into canals has plagued irrigation engineers for a long time now. Many methods to reduce sediment entry to canals have been attempted. However traditional anicut shape, described in this study, has not received attention in this regard. Similarly the idea of having depressions in the crest to aid sediment transport over the anicut remains a neglected area. Two divergent cases of traditional anicut shapes were considered - one designed to reduce sediment entry into canals and the other - a side-weir designed to increase the sediment transport to a distributary.

Preliminary experiments to compare the behaviour of traditional and modern anicuts and also side-weirs were conducted on a fixed-bed physical river model. Flow visualisation experiments indicated that curvature of the diverted flow is greater in the case of modern anicuts and they are thus likely to attract more bed sediment into the canal. At low flows, the traditional anicut diverted more flow to the canal than the modern anicut. The situation was reversed at high flows (i.e. flood flows). In each configuration, the effect of the presence of a small slot was also examined. It was found that the slot increased the flow velocity over it but also lowered water levels locally leaving the net discharge little affected. It however, created stronger uplift velocities locally, especially for the near-bed flow that was attracted up and over the slot.

Mobile bed studies were also conducted by modifying the set-up i.e. attaching a sediment feed mechanism. First the sediment transport over a side-weir was investigated. Experiments on a traditional and a modern anicut configuration were also conducted. All experiments were run to equilibrium. For a given discharge, the modern weir attracted 80 % of the sediment to the canal while the traditional weir attracted 50 %. The water surface levels showed that the traditional weir resulted in lower water levels which is useful under flood flow conditions. Although quantitative measurements were made, the conclusions reached from these experiments can serve only as qualitative guidelines of possible prototype behaviour. The experiments do indicate however that this line of enquiry shows promise.

One tank system with 200 tanks was also investigated for its rainfall, runoff, silting rates and overall sustainability. This system is located in a region of high rainfall variability both temporally and spatially. In such a semi-arid region, under unreliable rainfall conditions, the tank system characteristics were shown to optimise food security.

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