OPTIMAL ALIGNMENT OF A CANAL ROUTE

by

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Submitted in partial fulfillment of the requirements of the degree of

Doctor of Philosophy

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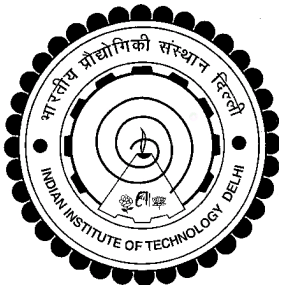

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CERTIFICATE

This is to certify that the dissertation entitled, **"Optimal Alignment of a Canal Route''** is a bonafied record of project work carried out by **Mrs. Sridebi Basu** in partial fulfillment of the requirement of the degree of Doctor of Philosophy. She has worked under my supervision and guidance at Indian Institute of Technology Delhi, and has fulfilled the requirements for the submission of her report.

The results presented in the report have not been submitted in part or in full to any other University or Institute, for the award of any degree or diploma.

New Delhi

October 2013

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ABSTRACT

Water is the most valued natural resource for mankind's sustainable development. India is getting water stressed as water demand is increasing due to modernization and as a result. The natural allocation of water resources over space and time is irregular in Indian scenario which makes the situation more complicated. Due to its geographical location, India is having both extreme dry climate as well as wettest place of Earth. Seasonal rivers are having intermittent and flash flow whereas perennial rivers continuously discharging huge volume of water to the sea. Thus allocation of water resources is required to balance between the surplus and deficit areas of the country. Interlinking of rivers is envisaged for interbasin transfer of water.

The channel must be capable of transporting water between the source and the destination in a secure and cost effective manner. Canal design includes canal cross-sections design. It also comprises horizontal and vertical layout design. In an ideal condition the minimum cost of canal route alignment means the minimum cost of canal section per unit length multiplied by the shortest distance between source and destination but that may it not possible due to practical considerations. The layout depends on the prevailing topography. The shortest distance may not be feasible or optimal due to many reasons thus optimal route to be studied. The minimum cost canal alignment is a complex function of cost of land acquisition, earthwork, lining, water loss and canal structures. The canal along the natural ground slope may have least excavation cost for canal section per unit length but due to maximum travelled path the total cost is higher than other options. In contrary, the shortest route will increase earthwork cost per unit length, cost of falls/drops and cross drainage works. The minimum cost of the alignment can be accomplished by minimizing the total cost of canal route alignment

considering all possible cost factors. Design of minimum cost canal alignment involves minimization of sum of earthwork cost which varies with canal geometry and topography of the area, cost of lining which varies with type of lining; cost of water loss which varies with soil properties if unlined and meteorological properties of the location; land cost which varies with land use pattern, resettlement and rehabilitation cost, environmental cost and alignment of the canal; cost of canal falls/drops which varies with type and height of fall; cost of cross drainage works, subject to uniform flow, mass balance condition and other topographical and local restrictions. Such minimum cost canal route alignment problem results in non-linear objective function and non-linear equality constraint, making the problem hard to solve analytically. Solution of such problem requires special optimization techniques. The complexity is reflected in the design equations for minimum cost canal route alignment.

The canal route alignment problem is a variational control problem. The optimal alignment of a canal route is a nonlinear optimization problem with non linear equality and inequality constraints. In special cases it can be converted into fixed boundary or moving boundary control problems. In general the problem can be solved by dynamic programming, but the present formulated problem could not be solved easily using conventional methods like GA, PSO, ACO, etc due to its complex nature. Hence, in this study the same has been solved using hybrid approach of dynamic programming and Dijkstra's method for global solution and considering the flow along the restricted area. The same is solved with the help of macros on MS Excel. The software solution will reduce the computation time for selection of optimal alignment of a canal route and will allow more options to explore. Due to speedy selection the desired route the project duration will be abridged which is beneficial to end users.

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