DEVELOPMENT OF AN ALGORITHM FOR OPTIMUM ALLOCATION OF MULTIPLE TEAMS TO BOREHOLE DRILLING SITES

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"I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any University or other institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text"

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To

Mining Engineers of GSMB,

who are seeking ways

to optimize their technical process

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ABSTRACT

Borehole drilling is one of the geotechnical investigations for foundation designing process of the construction industry. The growth of the construction industry requires an effective utilization of borehole drilling teams for the borehole drilling sites. It is similar to sending multiple travelling salesmen for multiple locations under the minimum over all travelling distance. In the borehole drilling, there are mainly two types of borehole drilling teams: wash boring teams and wash boring/ core drilling teams. And there are different accessible time periods for the sites. The service time of the locations are different and it can be predefined from the nature (number of holes, ground conditions, drilling length...etc.) of the drilling site job. It is expected that the difference of the total work duration among teams should be in an accepted level of difference.

The research outcome was an algorithm to provide a heuristic solution, answering which team does which job and when it is. Initially, filtering the job list was done, to group similar type of jobs together and, then groups the jobs, which require completion before the shutdown of the drilling teams. Clustering the two dimensional drilling sites to given number of teams were done to separate the jobs among the drilling teams. The outcome drilling site clusters total service time duration differences were minimized to a given accepted difference level by iteratively shifting jobs from the cluster, which has maximum total service time duration. This balancing was done with the minimum effect to the mean distance to the cluster centroids and avoiding oscillating between intermediate solutions of the iterations. The drilling site locations distance matrices were modified by adding the 'office location' and replacing 'big M' values for main diagonal distances of each outcome cluster and, sent through the Hungarian method, which is used for solving assignment problem in operational research. The outcome of the Hungarian method is the shortest path or set of sub routes. One of the distances of a respective two locations containing sub routes was replaced with 'big M' and rerunning through the Hungarian method was done. The graphical representations of given sub routes were taken as a guide for designing of the shortest path of each clustered drilling sites. When the number of drilling sites in a cluster is higher than ten, the given approach will become tedious, but in the geotechnical investigations industry it is not ranging higher than ten.

The above mentioned algorithm of allocation of drilling teams to multiple drilling sites, were shown better optimization over the traditional practice of 'instant team allocation for nearest location'.

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LIST OF ABBREVIATIONS

Abbreviation	Description
2D	Two Dimensional
ACO	Ant Colony Optimization
ATSP	Asymmetric Travelling Salesman Problem
CDWB	Core Drilling and Wash Boring
CTSP	Competitive Travelling Salesman Problem
GA	Genetic Algorithm
GTSP	Generalized Travelling Salesman Problem
HRL	Hierarchical Reinforcement Learning
IP	Integer Programming
MTSP	Multiple Travelling Salesman Problem
MTSPTW	Multiple Travelling Salesman Problem with Time Window
MVRP	Multiple Vehicle Routing Problem
NN	Neural Network
PDP	Pickup and Delivery Problem
SEC	Sub-tour Elimination Constraint
STSP	Symmetric Travelling Salesman Problem
TSP	Travelling Salesman Problem
TSPPC	Travelling Salesman Problem with Precedence Constraints
VRP	Vehicle Routing Problem
VRPTW	Vehicle Routing Problem with Time Window
WB	Wash Boring

LIST OF ANNEXURE