OPTIMISING EARTHMOVING BY LINEAR PROGRAMMING AND COMPUTER SIMULATION

by

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ABSTRACT

The accuracy of planning and estimating of earthmoving operations in any highway construction is important for both successful tendering and high profit margins. Mass-haul diagrams and experienced engineering judgment together with deterministic methods have been the key factors in planning and estimating earthmoving operations. Despite this, the limited use of Mass-haul diagrams and inaccuracy of deterministic estimates are well known. Although Stochastic and Linear Programming methods were developed to overcome some of these limitations, those available hitherto are relatively fundamental and are not bold enough to incorporate most real life problems.

After identifying the need for a relatively quick and accurate planning and estimating procedure, a new approach was developed by combining Computer Simulation and Linear/Integer Programming. The developed model was named RESOM; an acronym for Roadwork Earthmoving System Optimisation Model and was developed in three basic stages: simulation model; LPIIP model; and network model. RESOM can be applied to any road project to obtain an optimum earthmoving plan including material distribution, plant utilisation incorporating real life problems and constraints.

The main aims of the simulation model were to obtain realistic unit costs and production rates using balanced plant teams. Various cycle element times of earthmoving equipment were obtained from standard distributions fitted onto field data collected from four sites in Sri Lanka. Comprehensive LPIIP formulations were developed incorporating constraints like project duration, plant availability, sequence of operations etc. to obtain an optimum earthmoving plan using the simulated results. The third stage of RESOM involved the presentation of the selected earthmoving plan in the form of network diagrams and barcharts.

RESOM was successfully validated using two actual case studies (Anamaduwa Gam
Udawa, Sri Lanka, and the A42 - Measham and Ashby By-pass, UK). Application and experimentation with RESOM were explained using two other case studies (the M40 - Banbury By-pass and a hypothetical example) and proved that about 20% cost savings can be obtained. The experimentation process revealed that RESOM could be of considerable help in planning, estimating and obtaining optimum earthmoving plans.