Block transportation planning in a shipyard

Sang-Hyup Lee

Department of Industrial Engineering, Graduate School
Pusan National University, Busan, Korea

Hundreds of blocks produced by various shipbuilding operations are assembled to erect a ship at the dock in a shipyard. Given the fact that these blocks are continuously moved from one place to another in the shipyard, it is extremely important to handle these blocks efficiently. This paper deals with the planning of take-out and storage locations for these blocks, as well as the scheduling of block transportation in the shipyard. In most of the previous researches on problems related to the block stockyard operations, it is assumed that each block is arranged on cell units among the $m \times n$ cells-stockyard or on the basis of the lot numbers of the stockyard. However, this paper describes the actual arrangement of blocks, which is based on the coordinates and sizes of each block in a stockyard.

The plan for taking out a block from the stockyard involves the determination of a moving route for transporting this block, as well as the search for obstructive blocks on that route. A tabu search algorithm for taking out several blocks is developed to minimize the number of obstructive blocks taken out together with the indispensible blocks from the stockyard. The results of computational experiments show that the developed algorithm is useful for devising a plan to take out several blocks from the stockyard. Further, algorithms for generating a precedence constraint for the take-out plan of blocks and for ensuring the separation of indispensible blocks from obstructive blocks are developed. The result of the computational experiments shows that the algorithms perform well for several cases.

It is possible to devise various take-out plans for blocks that are expected to be transferred without changing the number of obstructive blocks by swapping other blocks in a stockyard. With regard to the general scheduling problems, it should be noted that block transportation scheduling requires only a fixed sequence of the blocks to be taken out. On the other hand, the algorithms for block transportation scheduling, described in this paper, determine the number of blocks transferred from some optional obstructive blocks and schedule block transportation operations by taking into account their alternative transporters. This problem is a flexible job-shop scheduling problem (FJSP) with “AND”/”OR” precedence constraints in the operations or the integrated process planning and scheduling (IPPS) problem in a flexible job-shop. To solve this problem, this study develops some methods such as mixed-integer linear programming (MILP), a heuristic method, and meta-heuristic methods. To use meta-heuristics for the abovementioned problem, a representation of individual and

schedule builder that produces a legal and feasible solution for the problem is developed. In addition, genetic and tabu search algorithms are developed on the basis of the proposed schedule builder. The results of the computational experiments show that the developed meta-heuristic methods are very effective in solving the given problem.

After the transportation schedule for the blocks is established, the location of each transferred block should be determined at its destination stockyard. Most of the previous studies related on this type problem have determined the storage locations of the transferred things under the condition where there is no restriction on the types of approaching a stock area. An algorithm for determination of the storage location of a block transferred to a stockyard is developed; this algorithm includes the procedure for checking whether the block can approach the destination stockyard or not by considering the location of the entrance and the status of the block arrangement in the stockyard. The algorithm also determines the storage location of the transferred blocks in order to maximize the available space of a stockyard after all the transferred blocks are positioned at the stockyards.