The success of construction projects depends on proper use of construction equipment and machinery to a great extent. Thus, appropriate planning and control of the activities that rely on construction equipment could have significant effects on improving the efficiency of project operations. Cranes are the largest and most conspicuous construction equipment, widely used in typical construction sites. They play a major role in relocation of materials in horizontal and vertical directions on construction sites. Given the nature of activities relying on construction cranes in various stages of a project, cranes normally have control over the critical path of the project with the potential to create schedule bottlenecks and delaying the completion of the project. This dissertation intends to improve crane operations efficiency by developing a new framework for optimizing crane service sequence schedule. The crane service sequence problem is mathematically formulated as an NP-complete optimization problem based on the well-known Travel Salesman Problem (TSP) and is solved using different optimization techniques depending on the problem's size and complexity. The proposed framework sets the basis for developing near-real time decision support tools for on-site optimization of crane operations sequence. To underline the value of the proposed crane sequence optimization methods, these methods are employed to solve several numerical examples. Results show that the proposed method can create a travel time saving of 28% on average in comparison with conventional scheduling methods such as First in First out (FIFO), Shortest Job First (SJF), and Earliest Deadline First (EDF).