Importance of 3D Visualization in Mobile Crane Operations

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Modular construction is a process in which a building is constructed off-site, under controlled plant conditions using the same materials and standards used in on-site process. Modular construction meets the builders' requirements for an environmentally-friendly construction process and reduced construction time at cost competitive prices. Lift planning plays a significant role in modular construction. Hasan et al identified the disadvantages associated with lift planning. Lift planning consists of four steps namely: 1. crane location; 2. crane selection; 3. support system design; and 4. motion planning. The current lift planning process uses static 2D method which leads to incorrect crane-operation design. It provides less clarity and causes misunderstanding and miscommunication among the participants. It also increases the probability of crane relocation and collisions. In order to overcome the disadvantages associated with the current lift planning process, 3D visualization method is proposed. It selects the best crane operation scenario by identifying and eliminating scenarios with spatial conflicts. 3D Visualization is further applied to a real time project to understand the impact. The proposed methodology generates outputs based on the considered inputs and criteria. The following inputs are given: 1. building and lifted object identification; 2. site information; 3. crane geometry database; and 4. load rigging database. The following criteria are considered: 1. site limitations; 2. lifting capacity; 3. priority setting; 4. safety; and 5. allowable ground pressure. The following outputs are generated: 1. selected crane type; 2. selected crane model; 3. support reactions during crane operations; 4. collision-free crane path and 5. 3D visualization. Crane location is calculated using a 3D space-based process. The crane selection process involves: 1. lifting capacity; 2. required working radius; 3. lift height assessment; and 4. clearance check. 3D visualization is done using 3ds Max. After the development of 3D visualization, support system for crane stability is designed by calculating the support reactions. The calculation of crane support reactions consider both fixed and crane swing condition. The proposed methodology is expected to achieve the following: 1. identify and eliminate spatial conflicts; 2. increase productivity by avoiding crane relocation; 3. improve understanding and communication among participants; and 4. provide sufficient information about crane operations. The proposed crane lift planning was implemented for a modular-based construction project in Canada. After completing the initial lift planning, the 3D visualization model was developed using 3ds Max. The 3D visualization model was shared with all the project participants and the crane operator to create a proper work flow. The 3D visualization identified uncertain areas with possible collision errors. This improved the confidence level of crane operators. It helped the lift operators to perform all the critical lifts without resulting in collisions. The visualization also helped the project planners in designing the lifting schedule and the site layout, such as pick positions of modules for loading without compromising the safety, quality, and cost time savings associated with lift planning and execution. Thus, 3D visualization is found be helpful in verification and validation of crane operations. It helps with resource management, productivity analysis and site layout assessments for construction projects.

Key Words: 3D visualization, Crane operation, Lift planning