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Developing a precast production management system using RFID technology

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ABSTRACT

Radio Frequency Identification (RFID) is characterized with superior predispositions, including the recognition of multiple markers, communication ranges from five to six meters, and a storage database for thousands of data files. These unique features resolve data storage and record-reviewing difficulties, prevent repetitive data entries, and facilitate instant feedbacks.

The precast industry is a management-intensive sector, for which pivotal issues include methods relevant to the instant provision of acquired management information to executive managers, materials of precast concrete products, quality control inspection and inventory and transportation management information, and convenient data entry for frontline personnel.

It is anticipated to integrate usage of Personal Digital Assistants (PDA) and the application of Radio Frequency Identification (RFID). Using RFID tag and reader to collect the information, and then transmit the multi-faceted, mobilized information such as the production quantity, the materials quantity, quality control inspection and inventory and transportation management information to the manager office or the site worker via the PDA and wireless Internet.

This precast production management system which has been developed by the author and utilized in precast production management encompasses inspection of incoming materials, production process inspection, molds inspection, specimen strength feedback, and logistic and receiving management. The mobilized information frame elaborated in this proposal can, to certain degree, be regarded as a reference for the construction of a mobilized precast industry management system.

1. Introduction

The arrival of computers, communications, and consumer electronics, commonly known as the 3C, has changed all levels of human life. Through the 3C technique, the dissemination and acquisition of information will become more convenient in the future and the electronization management technologies are moving towards the mobilization management concept.

Radio Frequency Identification System (RFID) technologies have been widely applied to a variety of fields, particularly to commercial transactions and logistical management. Where the precast industry is concerned, the processing of complex management data requires the consideration of the portability and ease of processing for the development and application of an information mobilization system. Developments, therefore, in the Personal Digital Assistant (PDA) and associated mobilization technologies have further enhanced the development potential of the future information mobilization.

The precast industry is characterized by the synergy of the traditional manufacturing industries and the precast industry, while still requiring production lines and project sites. For years, traditional manufacturing industries have used barcode systems to manage finished products, yet the usage of barcode systems is inconvenient due to some problems: first, it is often hard to fix the barcode on the components or read the numbers on the barcode in a damp or dirty environment. Second, one must find the corresponding meaning of the numbers on the barcode before obtaining the needed information. This process of manually recording the numbers and finding the corresponding meaning makes it impossible to get instant feedback. The current precast production problems can be divided into two parts: inside the plant and outside the plant. Inside the plant, components must be produced according to schedule; over-early or over-late production will result in storage problems and delays in the construction site. Furthermore, the components in store are very hard to locate using the traditional method, thus the process of finding takes a long time. Outside the plant, the production and hanging of precast concrete components must go according to the schedule, so it is essential to know which component belongs to which floor and which part of the construction, but this cannot be done immediately using the traditional method like barcode. Using the PDA associated

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with RFID method, it is possible to know the current situation at the site from inside the plant, allowing production to follow up with the site progress. After the production and storage of each component, it is easy to quickly locate the target product when needed using the RFID tag.

Engineers in the precast industry conduct the majority of their activities outdoors and usually record plant management and quality inspection information such as the production quantity, the inventory quantity, the material quantity and the quality inspection information in notebooks; data are not entered into the computer for control processing until after returning to the office. Therefore, time and spatial gaps exist between the plant and the office, which cause not only reduced efficiency in the data management by the engineering personnel but also an increase in the number of data entry errors. When data cannot be written to or retrieved from the system in time, management may be deprived of advance decision-making opportunities due to the lack in data accuracy and timeliness. Through the combined usage of RFID and PDA, the plant can manufacture precast concrete components according to the construction schedule. After manufacture, information of the precast concrete components, such as which floor they belong to and quality control information, is input into the RFID. When it is time to transport the components to the construction site, their locations can be quickly found with the RFID, thus reducing the search time. RFID can also be used at the site, to quickly find out the hanging location of each precast concrete component.

Therefore, the advent of RFID technology and its bilateral communication properties provides a greater degree of flexibility for system control and information dissemination. Wireless transmissions make data exchanges much more convenient and eliminate the existence of time and spatial gaps between the plant and the office, thus enhancing data management efficiency. Use of these technologies will increase the precast industry's information processing and management efficiencies to enable management to acquire accurate and instant management information.

In the global economy and trade environment, the precast industry will face stiff international competition. If the domestic precast industry is to keep a competitive edge, industry management's first priority must be the introduction of information technologies and the use of electronic management tools. In the information digital era, the main key of fundamental competency is based upon the level of information and technology. Therefore if the development of digitalization in the construction industry can be sped up, the construction industry can be further upgraded to the category of mobilized information management.

The objective of this research study is to establish RFID technologies in the precast industry's production and inventory and transportation management systems. AS RFID systems are successfully introduced to the pre-cast industry, in addition to improving information accuracy and employee performance, industry management will be able to select appropriate data-processing instruments to be used by the frontline plant personnel for increasing the data-processing convenience and efficiency through the simplification of data processing methods. Using RFID technology will eliminate the time and spatial gaps existing between the plant and the office and will improve the quality of the components and operations. The instant tracking of information relevant to quality control inspection of the precast components and inventory and transportation management will enable the components stockpile management on a point-of-time basis and the thorough management monitoring at a comprehensive level.

The system which integrating RFID with PDA in the precast industry's production, inventory, and transportation management has already been developed by the authors and aplied on the production management of Ruentex's precast concrete components. Users can quickly locate the position of the precast concrete component in the plant and also find out the hanging location using PDA associated with RFID. With internet, users can further send the construction site percentage progress to the office, allowing the manager to check whether the schedule of precast concrete component matches the schedule of construction. Doing so, the manager can avoid the products being produced too slowly, causing delay of hangings, or the component being produced too quickly, causing shortage of storage space. The precast production management system is divided into two parts — quality control inspection management and inventory/transportation management. The quality control system controls the component's production quality. After the quality inspection, the system will automatically connect to the concrete materials purchasing system and the precast component molds inspection system to prepare for the concrete pouring and molding. The inventory/transportation system, which includes the inventory management system and the logistic management system, deals with the storage and transportation management of completed components.

2. Literature review

2.1. Precast production management

The main advantages of the precast production are a reduction of the workload on the construction site, simplification of complex work, and the production in the factory with well-controlled environmental conditions for improving the quality of precast products. Benjaoran and Dawood [10] proposed a production planning system for precast concrete management and an application of the most appropriate allocation of plant resources.

Informationize enables rapid transmissions of various types of information. Through the Internet, managers can instantly check precast speed and status through the platform flow not only for improving the efficiency but also for facilitating management integration, enhancing the quality of operations, and reducing unnecessary expenses. Low and Choong [7] proposed that as a result of applying a cost reduction management system, concrete suppliers significantly reduced costs under the point-of-time management.

2.2. Concept of RFID

RFID is the projection of radio waves and signals to transmit data and conduct wireless data retrieval and storage to identify the status of workers and object contents. It consists of two components:

1. Tag (also know as the Tag): installed onto or into the object to be identified.
2. Reader: depending on the design methods and the technologies used, it may be categorized as either Read-only or Read/Write.

Tags commonly include a wireless electrical device (transmitter and receiver), control chip, and sensor. In addition, many tags are equipped with additional interfaces (RS232, RS485, and others) to enable the transfer of received data to another system (PC, control system).

Acting as the data transporter in the RFID system, the RFID tag usually contains a coupling element and electronic chip. For a passive tag, when it has not been entered into the reader's receiving parameters, it remains completely static; it is activated only when the tag enters into the area defined by the reader's parameters. The reader supplies the power needed by the tag through; other data like time and tag contents are to be transmitted through the reader.

2.3. RFID applications

RFID has received much attention in recent years. Wal-Mart announced that it would require its 100 main suppliers to apply