9 RADIO FREQUENCY IDENTIFICATION FOR THE GRC INDUSTRY

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SUMMARY: Radio frequency identification (RFID) has been recently established for routine monitoring of construction works and projects for the Hong Kong market. Its current applications are mainly related to quality control and asset tracking. The purpose of this paper is to summarise the existing applications of RFID for concrete and to identify possible uses of RFID technology for the GRC industry.
KEYWORDS: Concrete, GRC, quality control, RFID, testing, tracking.

INTRODUCTION/BACKGROUND TO RFID

RFID tags have been around for more than 30 years and the first passive, read/write RFID tag was patented in the US by Mario Cardullo in 1969[1]. RFID for monitoring of construction and in particular concrete is a relatively new idea. RFID essentially consists of two main components; the first is the electronic tag used to store data and the second is the reading/writing device.

The electronic tag consists of an integrated circuit and an antenna. The tags come in all shapes and forms. Some are paper thin and others may be 200mm in length. There are two different types of tag; one is referred to as the active tag and the other is the passive tag. The active tag, as the name suggests, is always active and periodically sends out data and is normally powered by a battery. The passive tag is active only when activated by an external power source such as a reading or writing device.

Both active and passive tags have their own benefits and limitations. The main advantage of the active tag is that it can collect a large amount of information at regular intervals (from around 10 seconds upwards); however, it is limited by its power source. The main advantage of the passive tag is that its life span is far greater than the active tag but its data storage capacity is far less.

The reading/writing devices also come in various shapes and forms. Some are portable handheld, such as PDAs, and some are fixed, such as machine readable/writable devices that are coupled together with a computer.

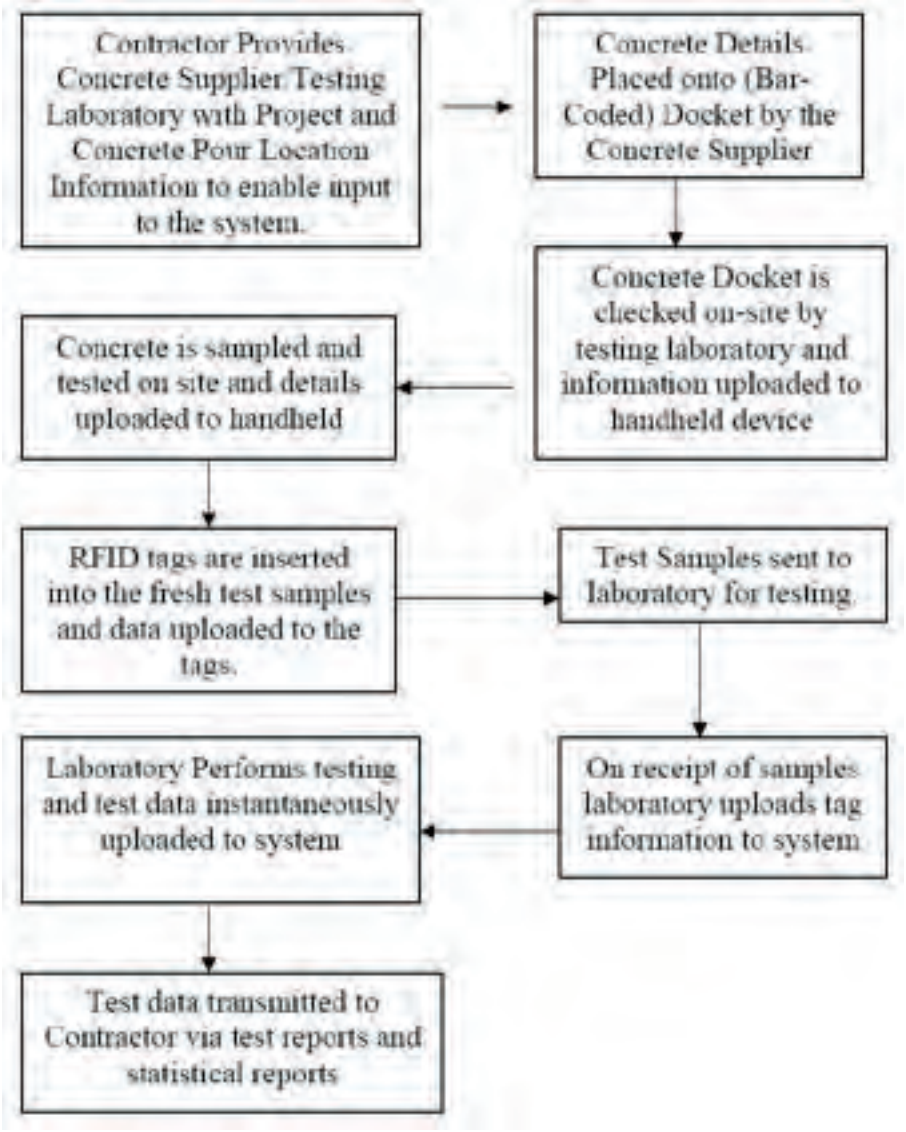
RFID CURRENT APPLICATIONS FOR CONCRETE

The use of RFID for the construction industry and in particular concrete is becoming more and more widespread. At present, in Hong Kong for example, RFID is used mainly for secure control of concrete testing data and to a lesser extent tracking of concrete elements.

Other applications around the world for RFID include making test measurements. Examples of this include temperature monitoring, strain measurement and maturity or strength data readings.

Control of concrete testing data by use of RFID has been established in Hong Kong for about 5 years and it has been used on several large civil engineering projects. On conservative estimates in the year 2004, somewhere in the order of 100,000 cubes and 80,000 slump measurements have been monitored with this system by Hong Kong companies.

Secure control of concrete testing data
Essentially the process is as depicted below.



In order for the system to work, there has to be good co-operation between the concrete supplier, the contractor and the testing laboratory. The main responsibilities of the three parties are as follows:

The concrete supplier: Provision of docket (preferably with a barcode) that contains the relevant information (e.g. time water added, mix code, plant ID etc.) about the concrete being supplied.

The contractor: Provision of the details of project information and location of concrete.

The testing laboratory: Provision and performing of all of the test data correctly and storage of the data onto the RFID tags.

Tracking of concrete elements
This is a lot more complicated as it involves not just the RFID concrete test data control but also a wide range of information uploaded to a tag that is this time inserted into the element being cast.

For this scenario examples of the information that can be uploaded to the tag are as follows: element design details such as reinforcement detailing, materials test data (not limited to concrete but including steel, aggregates, cement etc.), sources of materials used, handling/erection details, storage information, delivery information, audit/assessment information, inventory records, security & authenticity records, service records, maintenance records, safety records and the associated procedures.

As can be seen by the flow diagram (Figure 1) below there are many variables and hence the system process may vary greatly depending on the requirement of the contractor and their client.

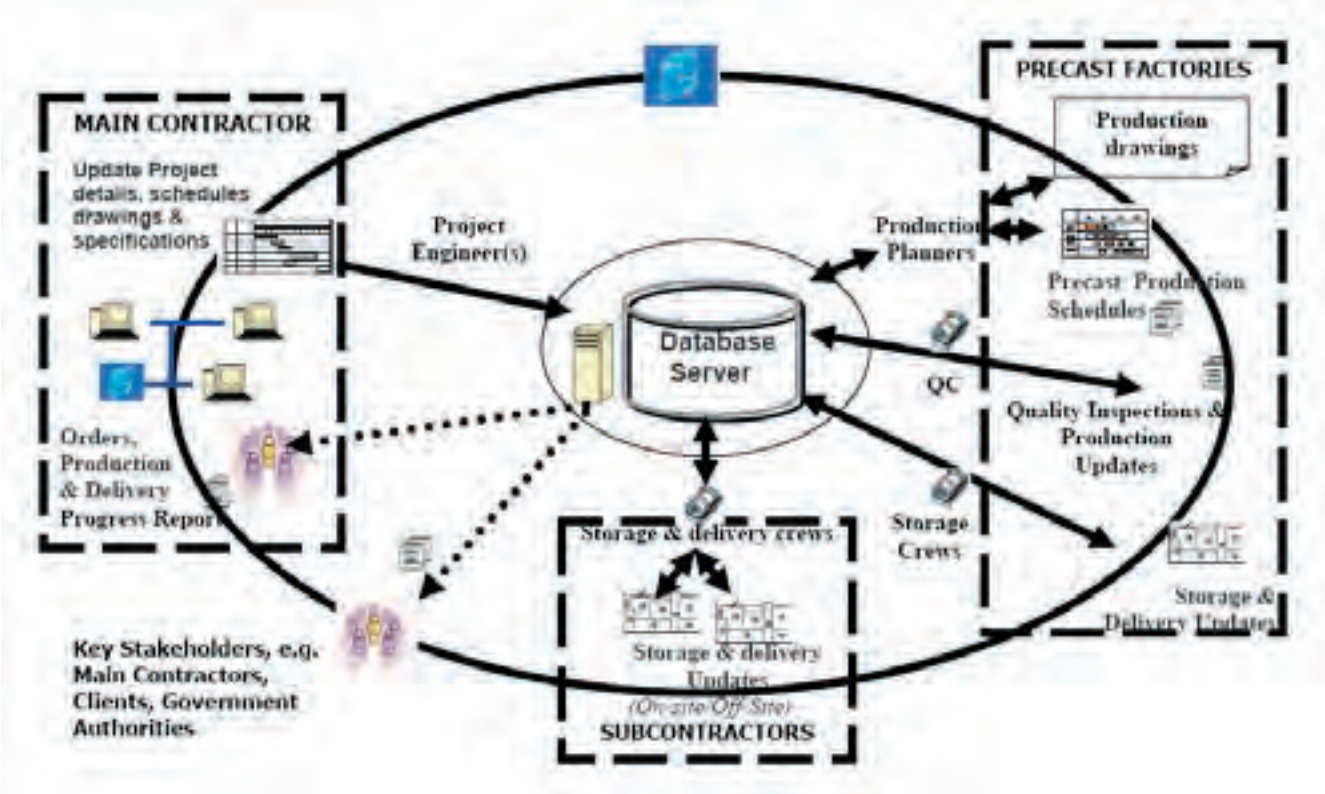


Figure 1 - Flow diagram

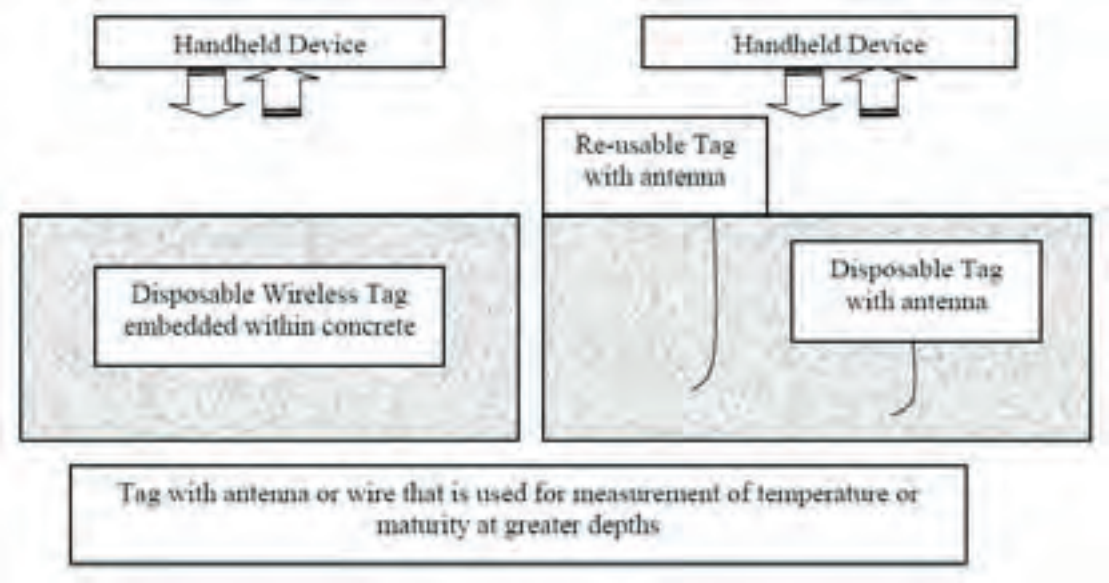
Making test measurements

For making and recording test measurements the tags are different to those used for the control/tracking tags. The control/tracking tags are normally of the passive type so that they can be used for a long period of time (most manufacturers claim up to 10 years); for the measurement of test data the tags are normally the active kind and contain additional sensors such as temperature or strain measurement sensors. According to manufacturers the battery life can be typically up to 1 year but the lifespan is dependent upon the battery size and the frequency at which information is collected.

For this, tags are inserted into the concrete element prior to casting. The tags are calibrated for the property being investigated (i.e. temperature/strain/maturity) and the battery is initiated prior to pouring the concrete.

The active tags used are essentially of two types, the first being totally wireless and the second with a wire which acts as an antenna. For the wireless variety, the tags tend to have a maximum depth of insertion into the concrete of about 200mm, whereas those with a wire may go down to much greater depths.

One main benefit of the wireless RFID tags is that they are not as prone to damage, especially when compared with the more traditional methods of measurements such as use of thermocouple wire for temperature measurement. As time goes by, the data is recorded into the tag and this is uploaded to a handheld device at user-friendly intervals. The tags will keep recording data until the battery has expired. Wireless embedded tags are currently used for the measurement of strain, temperature or maturity.



RFID FOR USE IN GLASSFIBRE REINFORCED CONCRETE

At present the use of RFID in GRC is very limited. But as can be seen by its uses for concrete, GRC has many possible applications that may incorporate RFID. Some will be realised within the next 2–3 years, others may take a little longer but are put forward as suggestions on how it may be used.

RFID in GRC in the short term

There are two main areas where RFID will most likely be used for GRC in the short term. The first is for the recording of test data and the second is for tracking of fabricated GRC products.

For the first case, the process will most likely be similar to that mentioned for concrete, with a few exceptions. First, the GRC supplier is normally the contractor and hence it should be easier to co-ordinate. Second, the test data that are recorded will not be the compressive strength data but rather the flexural data along with the fresh GRC and other hardened GRC test data.

For the second case, the tracking of GRC products can include similar information to that of concrete, but also other pertinent information such as fibre detail, spraying machine details, mould and specimen details.

RFID in GRC in the medium to long term

The following are put forward as suggestions that may become reality over a longer period of time for potential uses of RFID for GRC.

RFID for monitoring of movement of GRC panels

RFID tags may be inserted into GRC wall panels and the movement of these panels may be monitored by the use of handheld devices and displacement transducers incorporated into the tags.

RFID for heat and fire warnings of GRC products

RFID tags with temperature sensors may be incorporated into GRC products. These sensors can then be monitored at frequent intervals with a handheld device to check if any temperature rise is observed.

RFID tags for locating and identifying GRC cable troughs

RFID tags may be installed into GRC cable troughs. These troughs may then be easily located by use of a handheld device near the ground surface. Also, detail of the cables inserted into the troughs may be uploaded onto the tags and this information may be recalled at an instant.

RFID tags for monitoring thermal losses of buildings

RFID tags may be installed into wall panels and these panels monitored for heat loss. This may enable the optimisation of energy efficiency of buildings.

RFID tags for monitoring the acoustics of buildings

RFID tags may be installed with noise measurement sensors and the acoustics of a building could be monitored to check for noise-related problems. Since the tags could be installed within the panels, they will have minimal impact on the acoustics of the panel, especially with regard to the reflection of sound on smooth surfaces.

CONCLUSION

The use of RFID within the construction industry is rapidly expanding. It is only a matter of time before this has an effect on the GRC industry. This paper has highlighted some of the possible potential uses of RFID for GRC, but, as can been seen, there are many potential uses and only a few have been touched upon here.

ACKNOWLEDGEMENT

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REFERENCES

1 *RFID Journal*: Article 392/1/2