Building Trust

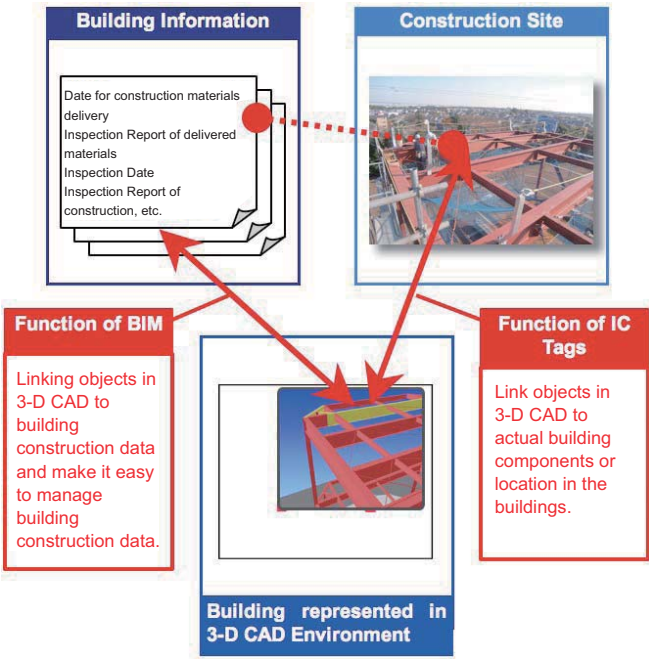
Leading-edge technologies such as IC tags and cell phones can play an important role increasing the sophistication of construction-related data management. Japan's Building Research Institute proposes a system based on the theory.

We live in a time when people demand reliability from industrially manufactured goods, from automobiles to household appliances. And construction is no exception in this regard. Crucial to ensuring reliability in buildings is assembling a framework wherein information concerning the quality of building construction, including but not limited to the quality of the materials and workmanship that goes into a given building, is provided to owners and occupiers of buildings alike, such that these parties will be able to purchase and use buildings with peace of mind.

Most of the information on building, such as the materials and methods used in construction, as well as the inspection procedures involved, is available in a specified location for a given period of time between the time a building is built and the time it is demolished. The information in question amounts to a tremendous volume: the data on the construction of a single building, if bound into printed volumes, would take several dozen volumes, each 10 cm (4 inches) thick. In many instances, the data on the construction of a building is administered by a limited number of parties who are directly involved with the design and construction of the building, while the documentation containing this information is disposed of when the designated period for maintaining such materials has elapsed. Even documents that are kept in perpetuity end up being put away in the back of warehouses, complicating efforts to find any given document with the passage of time. This situation makes it difficult to obtain desired information when that information is needed.

Owners and administrators of buildings may also change over time if a given building is used over an extended period, say, a century. It is crucial for new owners and administrators of buildings to know beforehand how the building was built, and what its structural history is, if they are to use that building with peace of mind over a long period themselves, and conduct appropriate maintenance as well. As mentioned, however, there is a tremendous amount of information concerning building construction, requiring a tremendous amount of time and effort to find any particular desired information contained therein.

Functions of BIM and IC tags in managing building information data



BIM: A Revolutionary Technology for Managing Information of Buildings

A technology that records all manner of information relating to buildings, such as blueprints, construction, maintenance, and management, is proliferating in the architecture and construction sectors. This technology, known as Building Information Modeling, or BIM, represents a break with the past: it relates and records information concerning the construction, maintenance, and management of buildings with constituent materials and places for buildings that are depicted with 3-D CAD (hereinafter "objects"), allowing ease of display of any required information with just a click on the materials, places, or other objects depicted in the 3-D CAD environment. The **figure** denotes the BIM concept. BIM provides functions that relate a wide range of information on construction, such as standards for building materials, construction inspection findings, and maintenance and management histories, to the various objects included in the 3-D CAD environment. Utilizing these functions requires a time-consuming effort to link each individual object to each piece of construction information, however. If each individual component and place in a construction site had its own ID code, and if that ID code were identical to that of a corresponding component or place in the 3-D CAD environment, it would be possible to automatically assign building information generated at a construction site to each respective corresponding component, place, or other object with the 3-D CAD environment. Assigning, and recording on computers, an ID code of a component A to information on an inspection conducted on the component A upon delivery at a construction site, for example, would facilitate the automatic linkage of such delivery inspection information with the object that represents the component A within the 3-D CAD environ-

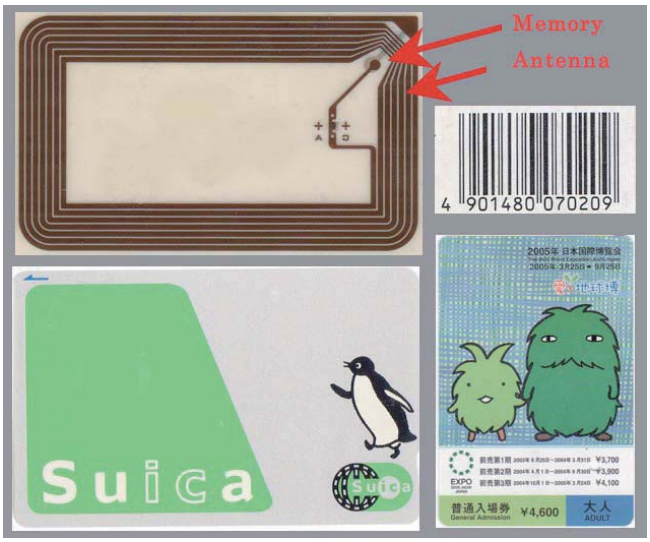


Photo 1. IC tags, East Japan Railways' Suica card, and an Aichi World Expo Admission ticket:
Upper left, back side of IC tag, memory unit and antenna; lower left, East Japan Railways' Suica Card; upper right: bar code; lower right: Aichi World Expo Admission ticket

ment. The question then becomes, how to assign ID codes to components and places in the real world? One answer is IC tags.

IC Tags: An Electronic Medium for Assigning ID Codes to Things and Places

An IC tag is a medium that is capable of recording text strings electronically. As depicted in **Photo 1**, the basic structure of an IC tag consists of a memory device, which stores text strings, and an antenna unit, which wirelessly transmits the text strings stored in the memory device so that they can be read by receivers. The memory device in an IC tag contains both read-only and rewritable regions, with fixed ID codes assigned to each respective IC tag stored in the read-only regions. These ID codes are ideal for use in assigning ID codes for use in distinguishing particular things and places, owing to the fact that they cannot easily be overwritten.

IC tags are being used in a wide range of sectors. IC tags are used in card keys that allow entrance to apartments and office buildings, for example. In these instances, the IC tag assigns an ID code to a key, which in this case is a thing, and a room, which in this case is a place. Pass cards now in common use on Japanese railways, such as the Suica (**Photo 1**), are IC cards too. The admission tickets to the Aichi World Expo, which took place in Nagoya in 2005 (**Photo 1**), also incorporated IC tags. In all of these cases, the IC tag assigns an ID code to an admission pass or ticket, which is a thing to be so identified.

Aside from IC tags, bar codes are also in widespread use as a means to assign ID codes to things; bar codes are assigned to practically all industrial products (**Photo 1**). Airlines operating domestic flights in Japan currently facilitate boarding without checking in at airports simply by downloading and printing out two-dimensional bar codes from the airlines' web pages. A machine reads the two-dimensional bar code and thereby determines whether the bearer is entitled to board the flight.

The biggest difference between IC tags and bar codes is that IC tags wirelessly transmit text strings to be read by receivers, whereas bar codes encode text strings into images, again, to be read by receivers. This difference is highly significant in the harsh and demanding environments of construction sites. For instance, products are frequently left stacked one on top of another when being checked on delivery at construction sites, such as per **Photo 2**. If these items were marked with bar codes, it would be necessary to ensure that these materials were loaded and stacked in such a way as to allow these images to be seen, whereas if they were tagged with IC tags, they could be stacked with comparatively greater ease, as it would be possible to read the tags so long as the broadcast signals could be picked up. Another advantage of IC tags is that they give off signals that can be used when conducting construction inspections or other processes in awkward or hazardous conditions, such as shown in **Photo 2**. Unlike bar codes, IC tags can be used without having to inspect an image straight on, even if they are in hard-to-reach places. Operating efficiency at construction sites is significantly improved as a result.

Photo 2. Advantages of using IC tags at construction sites:
Left, inspecting joins; right, verification of delivered components

Photo 3. Left, inspecting the members of a building framework; right, inspecting the condition of bolted joints of a steel structure. Both of these inspections use IC tags. The IC tags are used to display information required for various inspections on portable devices. Center, cell phone with an IC tag reader attached.

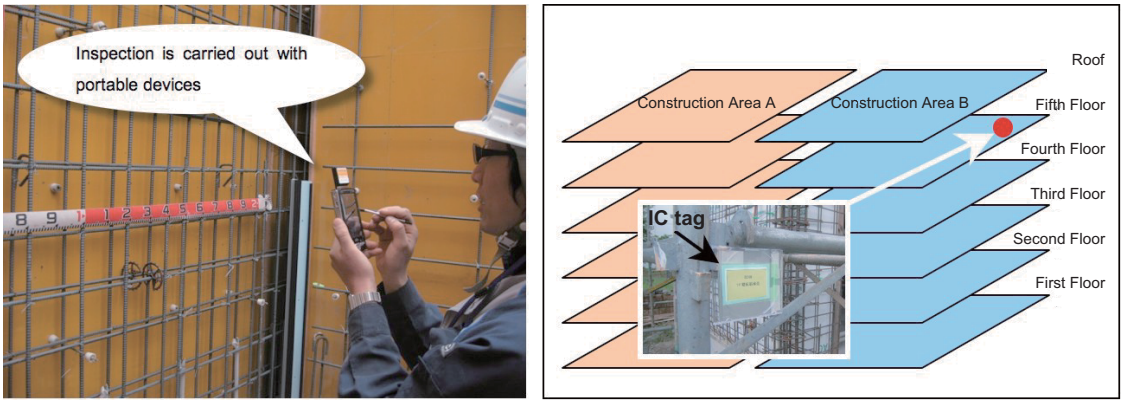


Photo 4: Left, using a portable data device to carry out an inspection of an arrangement of a reinforced concrete framework; right, IC tags are installed on to a floor and area wherein construction is carried out. The IC tags thus installed are used to display information required for various inspections on portable data devices.

Building Research Institute Proposes a System

Japan's Building Research Institute proposes a method of utilizing advanced technologies, such as IC tags and cell phones, in managing building information. The Institute's proposal is as follows: regulations mandate that specified inspections be performed at construction sites as each stage of the construction of a building is completed. IC tags would be used in order that these inspections are carried out both accurately and efficiently. As the IC tags described in this article may be used to identify things and places, placing IC tags in appropriate places at appropriate stages of the construction of the building allows those IC tags to assist in ascertaining the information that the necessary inspections are intended to obtain, because these IC tags will identify the stages and areas of the construction. Assigning and storing the ID codes from IC tags with the inspection reports will also allow easy identification by computer of the inspection data that is associated with given components and places.

Photo 3 depicts using the proposed system to verify the assembly of a building's steel frame construction. An IC tag is attached to each and every join of the components that constitute a building, and the construction inspection concerning these joins is carried out using these selfsame IC tags. The ID codes of the IC tags attached to the joins are appended to the construction inspection report, which is saved on computers, thereby allowing instantaneous searches of inspection data on particular joins.

Photo 4 depicts a verification of a reinforced concrete structure being carried out using the proposed system. An IC tag is readied and installed at the construction site for each specified item to be inspected in each specified place in the building. The ID codes of the IC tags that denote the specified items to be inspected in the specified places in the building are appended to the construction inspection report, which is saved on computers, thereby allowing instantaneous searches of inspection data concerning the specified items to be inspected in the specified places thereof.

Further Developments

Unlike industrially manufactured products, buildings are built one at a time. And it is true that the very fact that these buildings are built one at a time on a custom-made basis complicates efforts to adopt new technologies, such as IC tags. At the same time, there is a significant push to use advanced technologies such as the aforementioned BIM to manage information pertaining to buildings in a more sophisticated manner. It is possible that there will be greater adoption of advanced technical devices such as IC tags in the architecture and construction sectors in times to come, through the combination of advances in portable information devices such as the iPad and new technologies in architecture and construction such as BIM.