Efficient Road Maintenance Method using Computerized Road-Register Data

Sung Phil SHIN[a], and Inchul YANG[b], and Sung Hwan KI [c]

[a,b,c] *Korea Institute of Construction Technology, Gyeonggi-Do, 411-712, KOREA*
[a] *E-mail: spshin@kict.re.kr*
[b] *E-mail: ywinter75@kict.re.kr, Corresponding Author*
[c] *E-mail: ksjshjj@kict.re.kr*

Abstract: The Ministry of Land, Infrastructure and Transport (MOLIT) of Korea developed the Highway Management System (HMS) containing various road information including computerized road registers (RR) which is specified by law to be created and stored by road authorities in Korea. RR consists of drawings and attributes data, and the computerization project of RR has been underway since 2003 aiming to prevent damage or deterioration of paper-based RR and to manage and access the data efficiently and conveniently as well. In this study, we introduced a maintenance method of the computerized RR data from the perspective of the file structure and HMS system's operation. In addition, some solutions to resolve the existing problems of the method were proposed.

Keywords: Highway Management System, Road Register, Road Maintenance

1. INTRODUCTION

Road register (RR) is specified in Article 15 in the Road Act Enforcement Regulation according to Article 36 of the Road Act for its creation and storage. RR consists of five different drawings and images and forty-one attributes data forms as shown in Fig. 1. The RR data have been constructed since 1960's for all roads in Korea. It had been created and managed as a paper-based form until 2002, but the needs for computerization of the drawings and attribute data was arisen in order to prevent damage or deterioration of paper-based RR and to manage and access the data efficiently and conveniently. Accordingly, the RR computerization input guideline was created in 2003 based on which the RR data have been constructed, stored and managed in the Highway Management System (HMS) which is a software program on a basis of web and GIS containing various road information including computerized RR data and road facilities such as pavements, bridges, cut-slopes, traffic volume and others in the national highway, thereby providing the road managers with comprehensive road information. RR has been used in various road maintenance-related areas such as location finding, current status checking of the road facilities, borderlines and geo-utilities, finding of the drawings regarding facilities (bridges etc.), construction planning or maintenance construction information, and road field inspection. So, it is crucial in road maintenance arena to keep RR data secured and stored in a very efficient way. For this reason, this study introduces a management way of a large amount of the existing RR data (covering more than 8k km national highway) and an update process of the newly added RR data. In addition, a new filename assignment scheme is proposed which is appropriate for the existing HMS operation and easy to be understood by a DB maintenance administrator.

Figure 1 Structure of road register data

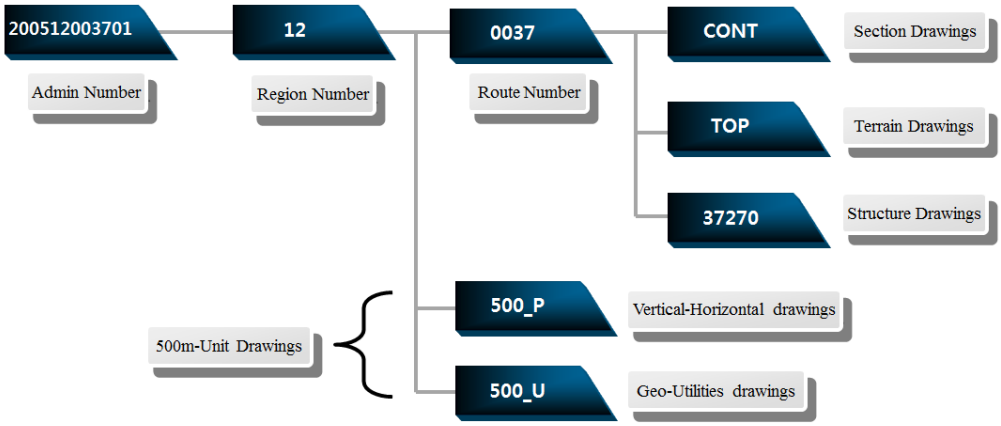

Figure 2 Structure of folders of RR data

2. ROAD REGISTER DATA MANAGEMENT

The RR data creation guideline is introduced in this section. Methods of how to create the RR data effectively are specified in the Road Register Creation Guideline (MOLIT, 2012) where the RR data are largely categorized into CAD(Computer Aided Design) drawings, image data, and attributes data. The CAD drawing data consists of several drawings such as Section Drawing, 500m Unit Drawing (Vertical-Horizontal Drawing and Geo-utilities Drawings), and others drawings as shown in Fig. 2. The Section Drawing represents the overview of the linear aspect of the road of interest. In the Vertical-Horizontal Drawing, plans and vertical cross-sectional drawings, and auxiliary facilities are designated as a single drawing form. The specification of geo-utilities is drawn in a plan view in the Geo-utilities Drawing. The Structure Drawing has a general and detailed drawing about main facilities specification such as bridges, tunnels and interchanges. Lastly, the contour lines can be seen in the Terrain Drawings.

Generally, the length of one route of the national highway is more than 300 km on average which is too long to be managed as a unit. Since 10~15 km is appropriate for a unit length for road management, we divide a route into several ‘RR-SECTIONs’ based on some

critical points such as bridges, administrative area boundaries and others. So a combination of route number, RR-section number and a distance from the starting point of a RR-section (kilometer-post) can specify a location of road facilities along the road. Accordingly, RR-section management is crucial and a basis for the RR data management. In addition, the unit length of a drawing is set to 500m. If the remaining extension at the last point of the RR-section is less than 500m, the size of drawing area can be shrunken less than 500m within the RR-section boundary.

The Fig. 2 represents the file/folder system of RR data. Generally, one CAD/image file corresponds to a drawing, and a bunch of files are included in a folder. A road construction section is assigned an admin number which is a root folder. The section could be divided into regions each of which corresponds to a folder whose name is its region number. Note that there are eighteen regions in Korea for road maintenance and a section could straddle two regions. Each region folder has three sub-folders; route_number, 500_P, 500_U. The route_number folder has again three sub-folders; CONT, TOP, 37270. The 500m Unit Drawing data are located in one of two folders of 500_P and 500_U appropriately, and Section Drawings in CONT folder, Terrain Drawings in TOP folder, and Structure Drawings in 37270 folder. Each drawing (CAD file) has its filename which is named under a principle of filename assignment for efficient management and fast searching purpose. The following subsection describes about the principle.

2.1 Filename Assignment Rule

It is important for computer file management to assign filenames appropriately and manage them accordingly. In order to secure the uniqueness of the drawing filenames, the filename of drawings is a combination of many attributes such as route number, section number, kilometer-post within a RR-section, administrative area (or region) code, structure code and serial number. The following sub-sections delineate the rules for each drawing in detail.

2.1.1 500m Unit Drawing

A number of 500m Unit Drawings exist for a RR-section from its starting point to the end. Route and section number gives its location and kilometer-post is adopted for the uniqueness of its filename within the RR-section. In addition, the capital letter P is used as an indicator for vertical-horizontal drawings and U is for geo-utilities. Thus the filename of drawings is assigned by the combination of route number (two digits) + RR-section number (two digits) + kilometer-post within a RR-section (three digits) + code (P or U).

500m Unit Drawings Filename Assignment Rule
⇒ route + RR-section + kilometer-post + P/U
⇒ ○○ + △△ + □□□ + P/U

2.1.2 Structure Drawings

Structure Drawings are constructed for every road facility in a road section. Before drawing filename assignment, the structure code is assigned first. Since more than one facility can be located in the same spot, kilometer-post is no longer an option. So, serial number is used instead. To construct the structure code, the serial number (three digits) for structures is used together with route number (three digits) and administrative area code (two digits). The administrative area code is in the place of RR-section unlike 500m Unit Drawings because the

structure information of road facilities needs to be managed within an administrative area. After that, the filename of structure drawings are assigned. Many structure drawing data (CAD files and images) correspond to a structure code, so the serial number (three digits) is added to the filename. Since the route number is no longer necessary for the drawings, the code is discarded.

Structure Code Assignment Rule
⇒ route + area + serial number of structure
⇒ ○○○ + △△ + □□□

Structure Drawings Filename Assignment Rule
⇒ area + serial number of structure + serial number of data
⇒ △△ + □□□ + ☆☆☆

2.1.3 Terrain/Section drawings

For both terrain and section drawings, the filename assignment uses alphabet "TOP" and "CONT" for terrain and section respectively, followed by the combination of route number (two digits) + RR-section number (two digits) + serial number (one digit).

Terrain Drawings Filename Assignment Rule
⇒ TOP/CONT + route + RR-section + serial number
⇒ TOP/CONT + ○○ + △△ + □

3. EXISTING PROBLEMS AND SOLUTIONS

From 80's through 90's a huge amount of roads have been constructed in Korea, and now in 2010's road maintenance such as re-pavement, facility installation, improvement of road linearity, and others has been the main work of road authorities. Accordingly, the length of construction site is quite random, so that the location of RR data could be anywhere within a RR-section, which leads to a need to change the filename assignment scheme to guarantee the uniqueness of filenames. To satisfy this requirement, the file system must be systematic with less complicated structure as well as provide easy management. Considering these criteria, a simple but appropriate filename assignment principle has been proposed as following sub-sections for 500m Unit Drawings and Structure Drawings.

3.1 500m Unit Drawings

The most problematic area in 500m drawings is that it cannot reflect the location within a RR-section accurately. The location indicated in a drawing currently uses a minimum unit of 100m. For example, a spot with a section of 03, a route of 19, a kilometer-post of 1,500m is represented as 19 (route number) + 03 (section number) + 015 (1,500m location) so that its filename is assigned as「1903015P」. However, if a kilometer-post is 1,568m, then the filename is not assigned as「1903016P」by rounding but discarding 68m so that filename 「1903015P」is assigned. That is, 10m unit of accuracy for kilometer-post cannot be expressed. If there are two drawings whose kilometer-posts are 1,418m and 1,488m

respectively, their filenames are assigned as「1903014P」, causing a critical duplication error. Moreover, if they are located in the same folder in the computer file system, one of them must have a different name due to a uniqueness rule of filenames in the same folder, which does not comply with the guideline.

Although the above example occurs rarely, the filename assignment should keep the uniqueness of filenames, which is more effective by avoiding the filename duplication. In order to resolve the problem aforementioned with regard to 500m Unit Drawings, the representation of a location within a RR-section needs to be improved. So, the existing 100m unit expression for a kilometer-post was replaced by 1m unit, and the length of a filename is extended from 7 to 9 digits. For example, drawings with a kilometer-post of 1,418m and 1,488m due to a different starting point in the same RR-section would have been assigned the same filename of 「1903014P」in the existing scheme. In the improved method, however, the filenames are 「190301418P」and「190301488P」respectively without duplicity.

Improved 500m Unit Drawings Filename Assignment Rule
⇒ route + RR-section + kilometer-post(in 1m) + P,U
⇒ ○○ + ΔΔ + □□□□□ (ex. 15.546km)

3.2 Structure Drawings

The uniqueness of a structure code is guaranteed by emphasizing on a serial number, rather than expressing a location within a RR-section like in 500m unit drawing. However, the number of structures can be a lot and the duplication problems could happen, which triggers the need for better filename assignment scheme. According to the current naming scheme in the guideline, for example, the Chohyun bridge located in route 45 in Gyunggi province (area code of 41) with the serial number of 93 is assigned the structure code of "04541093", and its filename is assigned as 41 (area code) + 093 (the last three digit of the structure code) + serial number (001). That is, the filename for the drawing of the Chohyun bridge is assigned as "41093001". The problem is that the area code and structure code are not intuitive for road managers, and the serial number scheme is impractical since there are a lot of newly constructed structures. Currently the number of data sets already managed exceeds 700,000. If a naming scheme is assigned by area code, structure code and serial number only, there will be potentially duplication problems in the data sets as well as having a difficulty of managing a newly added structure.

For the improvement of structure code assignment rule, it was required to modify overall structure. Although it could involve complicated filename assignment, it was expected that the improvement shall establish a uniform management system. As shown below, the combination of region code (two digits) + route number (three digits) + RR-section number (two digits) + serial number (three digits) was proposed for the new scheme. Here, the region code refers to the code that identifies 18 road authority offices in Korea while route number and section number are the same as in 500m Unit Drawings, which guarantees the uniqueness of the code and gives an intuitive understanding. The filename of structure drawings is created by just adding a serial number and discarding the region number.

Improved Structure Code Assignment Rule

⇒ region + route + section + serial number of structure

⇒ ▽▽ + ○○○ + ◇◇ + □□□

Improved Structure Drawings Filename Assignment Rule

⇒ route + section + serial number of structure + serial number of data

⇒ ○○○ + ◇◇ + □□□ + ☆☆☆

4. CONCLUSION

In this study, we introduced an efficient management method of a large amount of the RR data, and a new filename assignment scheme was proposed which is appropriate for the existing HMS operation and easy to be understood by a DB maintenance administrator. The proposed filename assignment rule can completely avoid the code/filename duplication problem and also facilitate convenient data classification so that the RR data can be managed more systematically and effectively.

In this study, road maintenance was attempted by the modification of code/filename assignment rule basically. However, in the future, an effective systematic management of RR data from the perspective of database system in HMS needs to be studied. Through the consideration of an efficient structure of DB tables and their relationship, RR data can be handled more stable and secured and also utilized in more areas. Finally, the management system based on drawings such as 500m Unit Drawings and Structure Drawing was considered, but a study of how to manage attributes data of more than 40 sets effectively is required in the future.

ACKNOWLEDGE

This research was supported by a grant from a Strategic Research Project (Development of road network analysis technology based on road lanes) funded by the Korea Institute of Construction Technology.

REFERENCES

Sung, Jeong-gon (2004), Application of spatial-temporal data models on the road management integration system, Korean Society of Road Engineers.

The Ministry of Construction and Transportation (2006), “2006 Road Management Integration System”

The Ministry of Land, Infrastructure and Transport (2012), “Road Register Creation Guideline”