Lifeline Earthquake Risk Assessment Database Design

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Abstract: Lifeline systems are these systems that relates to daily life needs, like water-supply, power, telecom, traffic, gas-supply, sewage and heat-supply, and so on. Strong dependence on lifeline system is one of the distinctive characteristics of modern urban area. Lifeline earthquake disaster brings not only property loss, but also functional damage to urban activities and socioeconomic loss. So, since 1971, the earthquake damage forecasting and Aseismic design of lifeline systems have been the two of the key problems in the field of Lifeline Earthquake Engineering (LEE). Different structural patterns and performance characteristics existing among these lifeline systems, the database for lifeline earthquake risk assessment is often complicate in order to meet the needs of analyzing model. In general, according to the requirement of lifeline system earthquake risk analysis, the database covers a series of coverages: earthquake hazard data, lifeline structure data, and kinds of analysis models, site data, forecasting result data, and aided design measure data. This paper introduces the characteristics of the database related to main six lifeline system, including its function, structural design and design criterion, contents, and update technique. Geographic Information System (GIS) is the important developing tool in this database. The data transform technique based on GIS is also presented.

1 Introduction

As the name implies, lifeline systems, which includes water-supply, power, telecommunication, transport, gas, medical rescuing and commanding system etc., are the most important infrastructure for daily living and production; however, it has been proved that the greatest risk for the lifeline systems is the earthquake disaster. According to the statistical report from a lot of earthquake surveys, the damage or malfunctions of lifeline systems is the key factor for huge economic losses during the earthquake invading. Lifeline systems earthquake risk assessment (LERA) is one of the most powerful tools to reduce earthquake risk of lifeline systems and one logical way to guide decisions about seismic safety of lifeline systems. Because of the complex of lifeline systems, different structural patterns and performance characteristics, the database design to assess their earthquake risk is very difficult. The paper presents the database design based on Geographic Information System (GIS). The data structure and data transform technique are shown herein.

2 Database Conceptual Models

Considered the requirements of earthquake risk analysis to lifeline systems, the database of Lifeline systems earthquake risk assessment is classified into two sub-databases, one is for the basic information database, and the other is for analysis models. The basic information database is more detailed classified into two types of data: earthquake hazard data and lifeline systems vulnerability data. The former includes: earthquake environment basic data---geological structure, earthquake zonation map, earthquake occurrence probability, historic earthquake information, and so on. The latter contains the entire datum of every lifeline system structure and construction, such as structural pattern and element, age, condition, materials, usage, site soil type, etc., for example, the datum of power system include the all related datum to power-generation factories, power lines, power poles, substations and their electric facilities. The database of analysis models covers a set of vulnerability analyzing models aiming to different lifeline systems and their components, and the earthquake hazard estimation models. This contents and structure of the database of Lifeline systems earthquake risk assessment can be summarized into Figure 1.

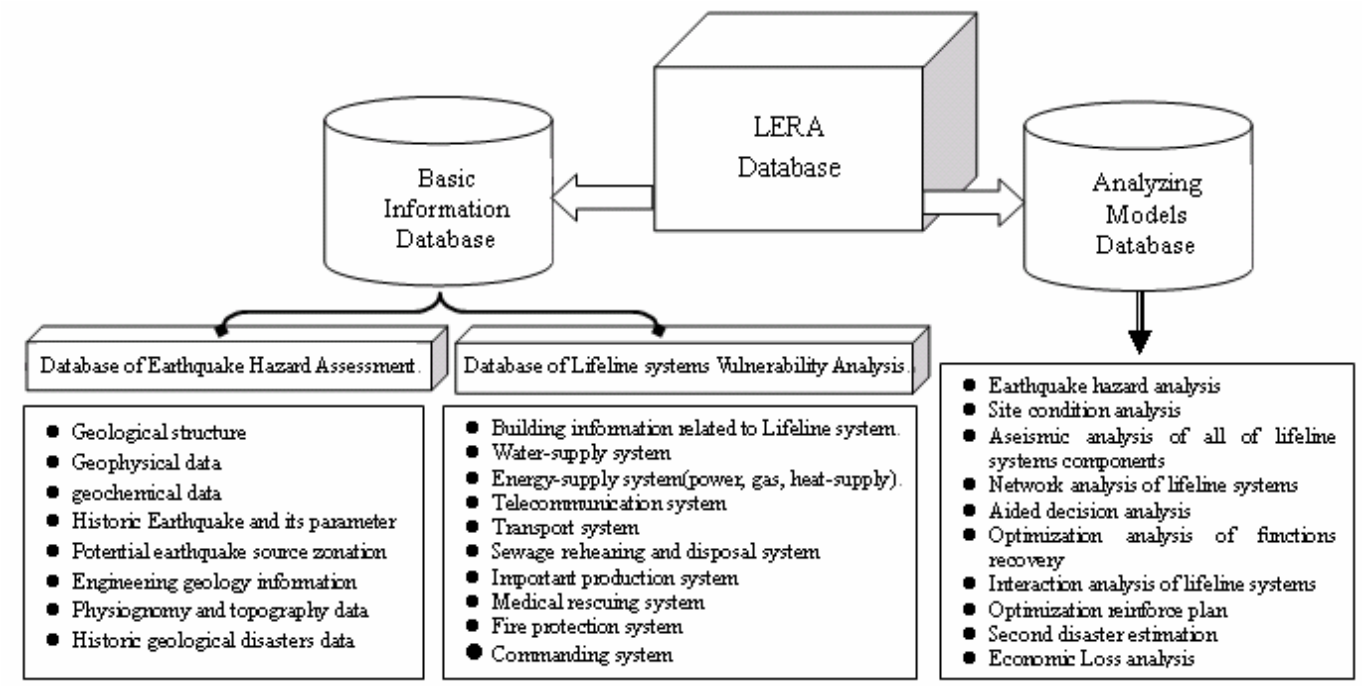

Figure 1. Database of LERA

3 Database Modeling and Building

The database is built based on GIS, which is a system of computer software, hardware and data, and personnel to help manipulate, analyze and present information that is tied to a spatial location. GIS is suited herein because of its powerful data management, spatial analysis abilities, and the characteristics that can operate the attributions of the objects and their spatial positions in the same time (maps and database are interactive). According to the requirements and characteristics of the earthquake hazard analysis methods and vulnerability assessment, combined with the data management function of GIS, the database modeling for LERA is designed into the coverage-stored models. Firstly, all objects will be classified into three types of datum according to their characteristics: point, line and polygons; Secondly, these three types are stored in the different coverages to meet the need of the analyzing models and then are classified into the corresponding directory, these datum or coverages that are applied into the only one analyzing model are exclusively stored in one directory, then these common datum and coverages are stored into the common directory according to their data types and contents. Figure 2 is a typical database of water-supply system based on GIS.

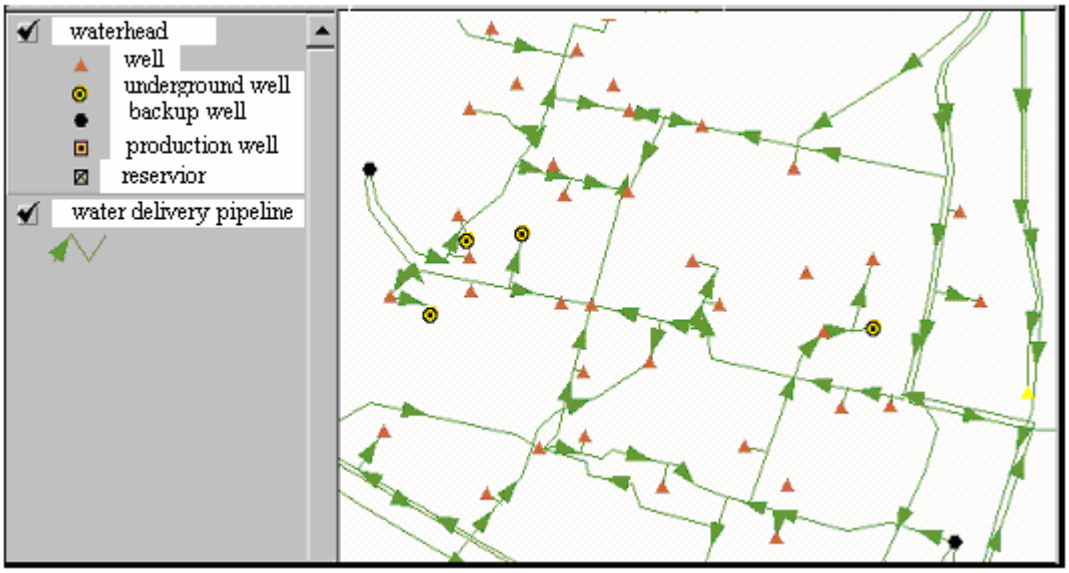

Figure 2 water-supply systems

4 Data Transform Technique

GIS can combine data from many sources. Parts of datum for these data models gets their inputs from the digital device, the datum originate from maps. The others can be got from other datum format files, such as CAD, TXT, satellite images and aerial photos, Global Position System, and tables of data, etc. Because the data format in GIS is grid and vector, the data must be transferred before they are used in GIS, some data--joint programs must be developed. Figure 3 shows a data transform basic procedure.

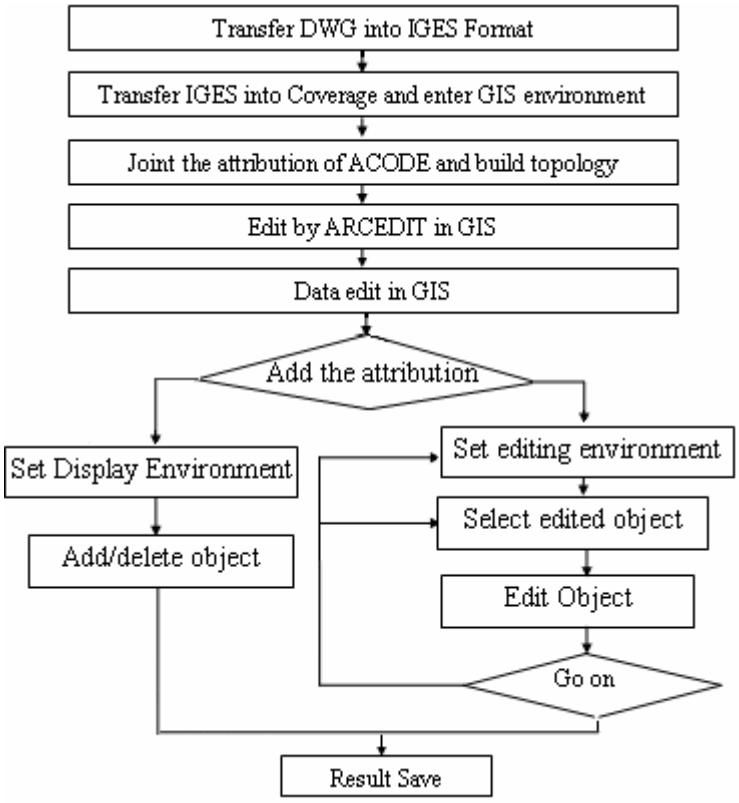

Figure 3. A illustration of data transform (transfer DWG file into GIS coverage)

5 Database Function and Integration

Beside the general database function, such as query, update, modification, add, delete and select, and so on, this database can shown the analyzing result in kinds of forms, like table, figure, voice, video, and text. Another special characteristic in that the map and database are integrated together, the database operation can be done in either the environment of maps or that of database. Multiple databases can easily be linked and related. The database owns also an excellent friendly interactive interface that is developed in the Visual C++ and Basic platform.

6 Conclusions

The database for LERA is a complicated database; it has been proven that GIS is an ideal tool to build this database. In fact, parts of the database can be used in other ways, like emergency services in no-earthquake condition, construction of lifeline system in future, and land management.

References

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