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PRELIMINARY SEISMIC SAFETY ASSESSMENT OF SCHOOL BUILDING USING CASE-BASED REASONING TECHNIQUE

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Abstract

This paper reports the progress of an ongoing research work on developing a case-based reasoning approach for preliminary seismic safety assessment of school buildings. This approach first constructs a knowledge base containing numerically simulated results from the detailed seismic safety assessments of various school building cases. Then, seismic safety assessment of a given school building can be estimated quickly by the knowledge base through a case-based reasoning process. In this paper, the basic ideas of the approach are discussed and the progress on the development of a case-based reasoning system for preliminary seismic safety assessment of school buildings is reported.

1. Introduction

Due to the 921 Chi-Chi earthquake disaster, seismic safety assessment of buildings has become one of the subjects on edge. Because school buildings usually serve as the temporary shelters after severe disasters, the safety of school buildings is very important (Wang, 2000). However, the amount of school buildings in Taiwan is remarkable and it would require a lot of work and budget to perform detailed seismic safety assessment on all the school buildings. Therefore, preliminary seismic safety assessment based on visual inspections is usually employed to get quick overall assessments on all the buildings. Then, only buildings still in question of danger are further investigated in detailed seismic safety assessment.

One popular detailed seismic safety assessment method in Taiwan is the Strength Ductility Method (SDM) (Ho et al, 1999). In this method, buildings are first modeled and analyzed by a building analysis computer program, such as ETABS[1]. Then the member forces computed by the ETABS program, assuming 0.1g earthquake input, are used by the SDM program to compute each floor's collapse ground acceleration. The smallest value of collapse ground acceleration among all floors of a building is therefore an indicator for its aseismic capacity. In this work, the SDM method is employed for detailed seismic safety assessment of school buildings.

Although preliminary seismic safety assessment based on visual inspection is quick and economic, its assessment results are far less accurate than those obtained from detailed seismic safety assessment and are often subjective because of the nature of human judgments involved in the visual inspection. On the other hand, detailed seismic safety assessment is more accurate and objective but also time-consuming and costly. In this work, a case-based reasoning approach for preliminary seismic safety assessment of school buildings is proposed. With knowledge base containing pre-computed detailed seismic safety assessment results of various school building cases, it allows for quick seismic safety assessment from the knowledge base using case-based reasoning technique but provides results with accuracy close to detailed seismic safety assessment.

The rest of this paper is organized as follows. Section 2 discusses the system framework of the proposed case-based reasoning system for preliminary seismic safety assessment of school buildings. In Section 3, discussions are given on how the knowledge base is constructed through knowledge acquisition from a significant amount of numerically simulated cases for seismic safety assessment of various school building models. Finally, some concluding remarks are given in Section 4.

2. System Framework

The system framework of the proposed case-based reasoning system is divided into three parts: the automated procedure of SDM, the knowledge base, and the case-based reasoning for preliminary seismic safety assessing system (as shown in Fig. 1). Microsoft .NET Framework[2] is considered for the implementation of the framework. Visual Basic .NET is used to implement the SDM program, which can access the building input data and member forces data from the ACCESS database of ETABS through ADO .NET technique. After the SDM program is executed, the assessment

[1] http://www.csiberkeley.com/
[2] http://www.microsoft.com/net/

results are calculated and saved in MS SQL SERVER 2000 database. As for the automatic knowledge acquisition from numerically simulated results, Visual Basic module[3] is employed to control the window-based interfaces of ETABS and the SDM program to achieve the automation..

3. Numerically Simulated Knowledge Base

In this work, the knowledge base contains numerically simulated cases that cover a good range of school building models. First of all, several parameters are chosen to control the automatic generation of simulated models. They are number of stories, number of classroom units, material strength of concrete, steel bars and reinforcements, type of structural system, etc. (Li et al, 2002). For the rest of information required in the seismic safety analysis, a "typical" building model is design based on statistical data (Chiu, 2002). After the seismic assessment of a building model is completed, the results are extracted to the knowledge base using automatic knowledge acquisition. As more building models are analyzed, the knowledge base get expanded along the process. In addition, the knowledge base should be also useful for studying the influence of the chosen parameters on the aseismic capacity of buildings.

4. Case-based Reasoning

Case-based reasoning is an approach to problem solving using previous experiences. Two major considerations in this approach are "Recall" and "Adapt" processes as shown in Fig. 1. The recall process identifies attributes and corresponding weight for the assessing case, then search for cases in the knowledge base with attributes and weights "similar" to the assessing case. All of the cases found within a certain degree of similarity are placed in the retrieve list and sorted by their degree of similarity to show their priority for retrieval. The "Adapt" process requires additional knowledge to modify the case descriptions. First, adaptable attributes are identified. The adaptable attributes are those attributes that can be changed, just like the parameters mentioned in the previous section. And then, this kind of parametric adaptation generates new solutions for the new cases. Finally, associated formula is evaluated to check the feasibility of the new case description (Maher et al, 1995). The procedure presented above is employed in this work implement the case-based reasoning module of the proposed system.

[3] The recipe of using Visual Basic module is provided form ETABS Technology Support Department.

5. Closure

This paper has presented a case-based reasoning approach for preliminary seismic safety assessment of school buildings. Compared with other preliminary seismic safety assessment methods based on visual inspections of experts, the presented approach is more quantitative and therefore more objective. Furthermore, it provides results with accuracy close to detailed seismic safety assessment but is efficient and cost-effective enough to serve the purpose of preliminary seismic safety assessment on large amount of school buildings. At this time of writing (November 2002), the implementation of the case-based reasoning system is still in progress. The mechanism for automatically performing detailed seismic safety assessment on a set of building models using the SDM method has been established. However, more work is still needed in construction of knowledge base and case-based reasoning module.

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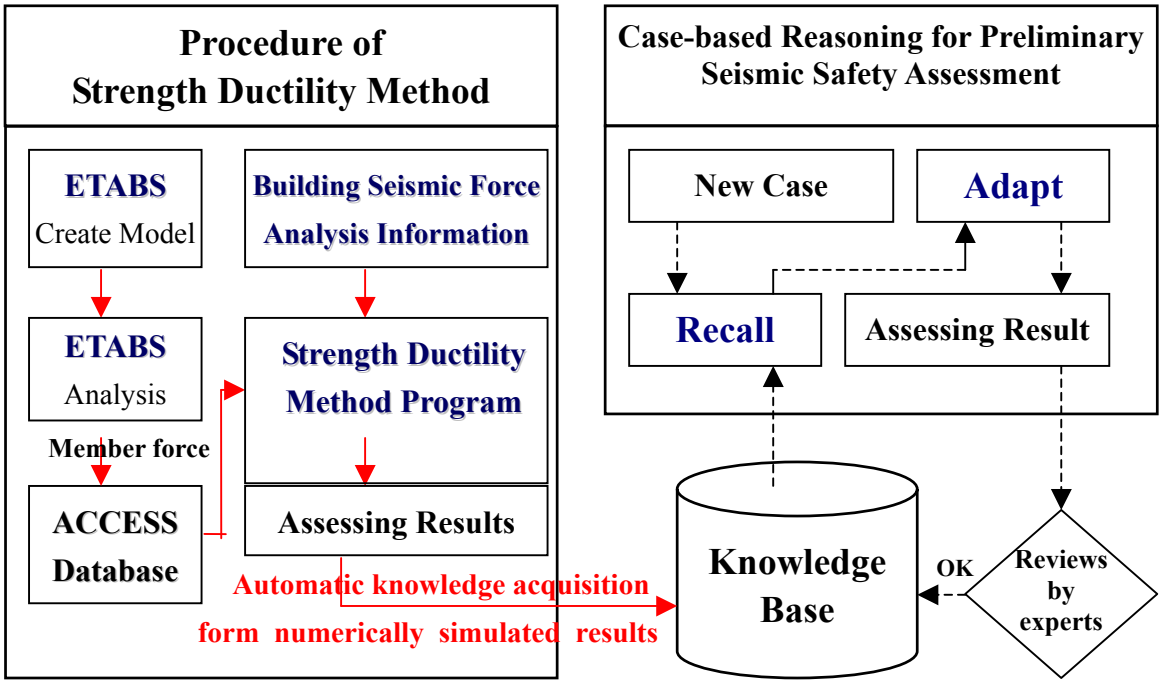

Figure 1. System framework