AUTOMATIC HAZARD INSPECTION MANAGEMENT SYSTEM OF RC BUILDING

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Abstract: There are lots of potential hazardous areas in Taiwan due to high-density land-use and construction building. Up to today, every city area in Taiwan is still continuously expending. Natural disasters such as earthquake, typhoon, flood etc. are happened from time to time within all year long. In addition, based on the high density of ecological environment, the careless or deliberate hazard such as arson fire, gas explosion etc. always randomly occurs. Such situations will cause serious life loss and citizen's properties damage once any kind of disaster happened. Therefore the hazard mitigation and prevention research is getting popular and important in Taiwan.

This study intends to build a hazard inspection and checking list of reinforced concrete (RC) building as the first step. Then based on the organization of this checking list, an automatic calculation and database management system will also be developed with Microsoft Access software. This checking list will contain three categories of every RC building, there are structure condition, fire preventing condition and using condition. Each category is organized with appropriate inspecting item. The goal of this research to organize such list for RC building's safety inspection is similar with human health inspection. From the checking result can find out the defect of each RC building and claims the necessary improvement. Then the potential hazard and damage of each RC building can be prevented.

Keywords: Hazard inspection, Hazard prevention, Inspection management system, RC building, Database.

1. PREFACE

1.1 The research background

Taiwan is positioning in the seismic region where lies on the Pacific Ocean and the path of western Pacific typhoon. This geographic situation causes lots of natural disasters, such as earthquake, typhoon and flood happened within all year long. Meanwhile, the economy is growing rapidly. High-density developing without geographic consideration causes landslide and debris-flow form time to time. Also, most citizens do not have enough disaster prevention sense and alertness. Because of that, there are many man-made accidents, such as gas explosions, fire disasters and airplane accidents always randomly occur [1].

Although Taiwan's government had been published "Disasters Prevention and Rescue Plan" in 1994 [2] , developed center, province, city, county / town and district four levels disaster prevention system. But some disasters still occur due to the management system is inappropriate. For example, the older buildings were not have appropriate management system. Therefore those dangerous old buildings are similar with potential bomb everywhere and endanger citizens anytime. Until today, there is not a formal operation principle to inspect buildings' safety. So how many dangerous buildings are still unknown. These will cause serious life lose and properties damage while disaster happening. This study is try to develop "Automatic Hazard Inspection Management System of RC Building" to decrease the influence and damage of disasters.

1.2 Objectives

To reduce the risk and potential hazard of RC building, there are two major purposes included in this research : 1. Developing an evaluation table of

"Automatic Hazard Inspection Management System of RC Building". 2. Giving grading score to inspected buildings and checking which building has safety problem to achieve management database automation. According to the inspection result, if some improvement and reinforcement can be made for the dangerous buildings then the destruction and damage loss can be reduce. Also if more and more data of RC buildings are collected. The system can build as a database and searched by citizens.

2. OLD BUILDINGS INVESTIGATION

To check the old buildings' situation, this research was investigated about 30 old buildings in Taipei City randomly; table 1 is the general information of these inspected RC buildings. Every building has different properties and situations, so only eyes surveying can be done and list as table 2.

According to table 2, wall and slab crack were the most common defects, second was water leak. If rank by happened frequency of defects, it will as follow in sequence:

(1) Wall crack
(2) Slab crack
(3) Water leak
(4) Paint drop
(5) Efflorescence
(6) Ceramic tile drop
(7) Pipe line expose
(8) Rebar expose and corrode
(9) Slab tile broken
(10) Emergency light broken
(11) Fire hydrant expired
(12) Beam crack
(13) Additional roof
(14) Settlement

Table 1. General Information of Inspected RC Buildings

NO.	Total slab area	NO. of floor		Structure type	Age (Year)
		Super	Base		
1	(4306.5 m^2)	10	3	RC	20
2	(792 m^2)	2	2	RC	27
3	(4950 m^2)	12	2	RC	11
4	(70422 m^2)	4	1	RC	21
5	(234501.3 m^2)	11	2	RC	12
6	1107m^2	4	1	RC	19
7	249.84 m^2 (1117.36m^2)	4	0	*	25
8	(About 7600 m^2)	7	1	RC	10
9	(2100 m^2)	3		RC	
10	3591 m^2	7	2	RC	7
11	2673.41 (69.448.22 m^2)	27	4	SRC	16
12	480 m^2 (912 m^2)	2	0	RC	About 90
13	4064.63 (42858.9 m^2)	22	3	SRC	16
14	About 330 m^2	3	0	RC	-
15	(1808.71m^2)	10	2	RC	-
16	272 m^2 (1091 m^2)	4	0	RC	10
17	(54193.72m^2)	10	1	RC	13
18	126 m^2	3	1	RC、BR	-
19	About 1226.3 m^2	10	1	RC、BR	25
20	815.67m^2 (6575.07 m^2)	8	1	*	13
21	2974.8m^2 (4184.08m^2)	21	3	SRC	17
22	861.7	5		RC	13
23	(36707m^2)	10	1	RC	30
24	1944.28m^2 (12751.98m^2)	6	1	RC	21
25	230.59 m^2	5		RC	10
26	(5032.80m^2)	5	1	RC	18

* : Can not recognize
BR : Brick Reinforcement

3. INVESTIGATION TABLE OF AUTOMATIC HAZARD INSPECTION MANAGEMENT SYSTEM OF RC BUILDING

Based on the result preceding buildings present situation investigation, experts of interrelated field, codes [3,4] and references [5,6,7,8]. This study finished an investigation table with the structure of "Automatic Hazard Inspection Management System of RC Building" as shown in table 3.

4. WEIGHTING EXPLANATION

In table 3, the determination of each item's weighting is according to the serious of disaster damage, which probably cause the degree of casualty to differentiate. It's importance to show specific items to the building, and the objectivism of the evaluation grade table.

This grade table divides tree rank to the weighting within all items：

(1)1st rank weighting：It's very important influence to show the safety of evaluation items, and probably cause casualty to persons who are in the building. So, giving the highest weighting "3" to show the items to the importance of the building safe.

(2)2nd rank weighting：It's not more importance than first rank. So give the next weighting "2".

(3)3rd rank weighting：When disaster happened, it only makes few casualty, but is must retain the item necessarily. So, give the weighting "1".

Table 2. Defects of Inspected RC Buildings

Building NO.	Crack				Paint drop	Slab tile broken	Rebar expose and corrode	Water leak	Ceramic tile drop	Pipe-line expose	Efflorescence	Emergency Light broken	Additional roof	Fire hydrant expired	Settlement
	Col	Beam	Wall	Slab											
1			ˇ				ˇ	ˇ		ˇ					
2			ˇ	ˇ	ˇ	ˇ		ˇ							
3								ˇ			ˇ				
4			ˇ	ˇ	ˇ	ˇ		ˇ	ˇ	ˇ	ˇ	ˇ	ˇ	ˇ	
5			ˇ	ˇ	ˇ	ˇ		ˇ	ˇ	ˇ	ˇ	ˇ		ˇ	
6			ˇ	ˇ	ˇ		ˇ	ˇ		ˇ	ˇ	ˇ		ˇ	
7		ˇ	ˇ	ˇ	ˇ			ˇ			ˇ				
8			ˇ	ˇ					ˇ						
9			ˇ	ˇ					ˇ	ˇ					
10			ˇ	ˇ				ˇ	ˇ						
11			ˇ	ˇ			ˇ	ˇ							
12			ˇ	ˇ	ˇ		ˇ	ˇ			ˇ				ˇ
13			ˇ	ˇ											
14		ˇ	ˇ	ˇ	ˇ			ˇ			ˇ				
Happen Frequency	0	2	13	12	7	3	4	10	5	5	7	3	1	3	1

Table 3. Investigation table of Automatic Hazard Inspection Management System of RC Buildings

Building name		Building address		Agent		Date	
Building NO.							

Investigation properties	Investigation type	Evaluation events		Weigh-ting	Grade			Grade	Sum
					First	Second	Third		
					1.0	0.5	0.0		
Structure Situation	Property Evaluation	Crack	Position	3	□At wall or slab and less than 6 twigs □None	□At beam or column but not in major shear stress or major moment region □In wall or slab and great than 6 twigs	□At major shear stress or major moment region		
			Wide	2	□Indoor and less than 0.3mm □Outdoor and less than 0.2mm ☐ At serious corrode region and less than 0.1mm	□Indoor and 0.3 mm ~ 0.5 mm ☐ Outdoor and 0.2 mm ~ 0.3 mm ☐ At serious corrode region and 0.1 mm ~ 0.2 mm	□Indoor and great than 0.5mm ☐ Outdoor and great then 0.3mm ☐ At serious corrode region and great then 0.2mm		
Fire prevention and refugee status	Fire control equipment	Fire extinguish instrument	Indoor fire hydrant	2	□Had installed and followed the demand of regulation	□Had installed but not follow the demand of regulation	□Not install as the demand of regulation		
			Automatic sprinkler system	3	□Had installed and followed the demand of regulation	□Had installed but not follow the demand of regulation	□Not install as the demand of regulation		
		Warning alarm	Automatic fire warning alarm	3	□Had installed and followed the demand of regulation	□Had installed but not follow the demand of regulation	□Not install as the demand of regulation		
			Handle warning alarm	1	□Had installed and followed the demand of regulation	□Had installed but not follow the demand of regulation	□Not install as the demand of regulation		
			Broadcast instrument	1	□Had installed and followed the demand of regulation	□Had installed but not follow the demand of regulation	□Not install as the demand of regulation		
		Sign equipment	Exit sign light	1	□Had installed and followed the demand of regulation	□Had installed but have defect	□Not install as the demand of regulation		
			Emergency direct sign	1	□Had installed and followed the demand of regulation	□Had installed but have defect	□Not install as the demand of regulation		
Use status	Significance evaluation	Used kind		3	□Residence	□Public place	□Height dangerous building		
		Used population	(8:00 to 17:00)	1	□Detained population less than 50	□Detained population 50~100	□Detained population great then 100		
			(17:00 to 8:00)	2	□Detained population less than 50	□Detained population 50~100	□Detained population great then 100		
Total									

5. INTRODUCTION OF SYSTEM

This research develops the investigation table as an automatic calculation and database management system. After entering Access and opening a new database, it includes table, query table, report, macros and module. In the follow will introduce which functions were used by this study.

(1) Table

Table was combined with rows and columns, every row's data means a set of records and every column's data called field, it means the appoint property of data. That add, delete and simple search can be done here. To establish a table contains two steps:

(I) Establish structure of database

(a) Select function table 「File / Open New Database」.

(b) Select empty database and press add.

(c) Select 「Design Inspect」 in 「Add Database Table」.

(d) Input column name, data type and adjust the attribute of column.

(e) Setup main index values (this research is use buildings number as index values).

(f) Save table.

(II) Input data

(a) Open database and data table.

(b) Input buildings data and adjust column wide.

(c) After data input press close to end the program, because Access will save automatically.

(2) Query

「Query」 is a convenient function for database. And that can show result rapidly in a lot of data, which find with limit condition. If this condition saves, it can search immediately and the result will renovate direct that follows with new data. 「Query」 use main index to let each limit data table of item to connect with another 「Query Data Table」. Structure number of main index connects the two tables of 「building basic data」 and 「importance examination」. Using main index can be related with the building and the examination table of it. The build step is as follows as these：

(I)Pressing 「add」 bottom in the label of 「Query」,and then user can select 「Design examination」 in the window of 「Add Query」. User can select 「Building Basic Data」 and 「Importance Examination」 that use building number to take as main index.

(II)Selection what wants to show is in the table that is select.

(III)It can show the query result after user pushed the bottom of 「Check」.

(3) Use Form

Application of form will transform monotone database input way of screen control (as shown in figure 1). It must not only have a clear indicator to user that input data, but also input data by form that can prevent change the item remove. It won't cause the problem of connect data. Otherwise it can use screen control to simplify data input, like set up 「Open the window」 (figure 2), 「Checking box」, 「Secondary form」 and 「Inspection groups」 (figure 3). Form provides model of style. It is more kind and humanity to user when they input data. The step set up as follows these：

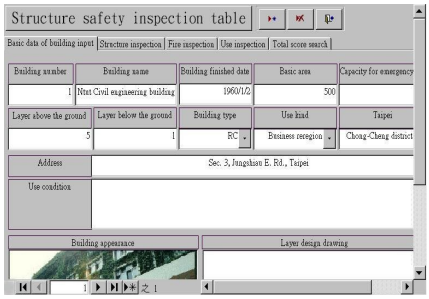

Figure 1 Input Table

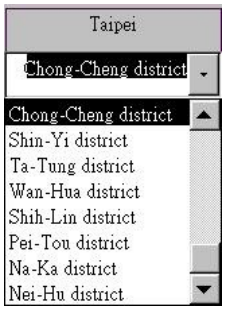

Figure 2 Opining the window

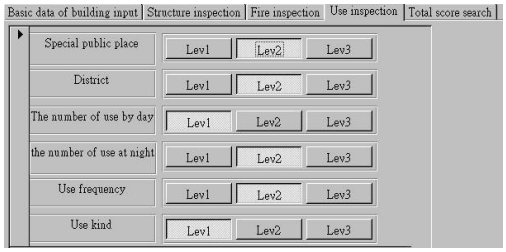

Figure 3 Inspection Groups

(I)Select 「Form」 label and press 「Add」 bottom.

(II)Select 「Form wizard」,and then use building database table to select necessarily field and form style. Later the form can be set up.

(4) Build report

Setting up report is similar to form. It can provide the printer result to user. It can more clear and live when use 「Secondary Form」.function.

According to the front part of setting up database, the system can set up building safety

examination table by 「Building basic data table」, 「Fire control examination data table」, 「Structure examination data table」 and 「Use examination data table」. This table of 5 parts contains s building basic data, structure status grade, fire control refuge status grade and use status grade and total grade. The using method of building safety examination table is as follows：

(1)when entering the data base of 「Building management」,user can open the 「building safety examination table」 and then input building basic data and examination. Before inputting building basic data, user must input building number. So, examination data can connect with building data.

(2)Selecting the page of 「basic data」 in the table, according to the true basic data of building, user can input the table of field in order. After inputting data, you just press, 「enter」 and then it can go to next field. Beside the 「enter」 and 「close」 bottom, one function is adding data and another is closing data input screen. When selecting close bottom, the new or change data will be saved.

(3)After basic data input, user can select one of the page that is 「Fire control examination」. User can enter fire control refuge status grade to grade. Each of the items of this examination table can select 「Inspection bottom」 immediately. For example 「fire hydrant」 is 0.5. User can use mouse to select fire hydrant and then select the bottom of 0.5. According to this step complete other items. When complete fire prevention refuge status grade, you can select structure status or use status to grade.

(4)Selecting one of the pages 「total」, and computer will be count total grade of total, fire prevention refuge status grade, and Use status grade and Building safety status. We will know the safety rank of this building.

(5)Some items of this table use 「fire prevention refuge status grade」 (like building style, use kind, district). User can select open window of field as for adding item, user can add in the table of building type, use kind, district.

(6)When continuously inspecting other building data, user must use 「record selecting bar」 (figure 4) to choose another new table for inspection.

Figure 4 Record Selecting Bar

6. CONCLUSION

This study investigates that there are 1/3 ratio of 10 to 20 years buildings compared to the whole old buildings. So old building is high proportion in Taiwan. Even if the surface of the building, which is older, doesn't have clear defect, but it may let strength decreased because material natural aging, or older building doesn't have perfect fire prevention equipment or doesn't conform to fire prevention regulation. But the building precaution estimation, which can inspect out a dangerous building, then can have preventable methods before disaster happened. Thus can decrease casualty by calamity. This automatic hazard inspection management system not only considers about traditional building safety and structure resistance of earthquake but also considers fire control refuge status and use importance status to think over the weighting respectively and total estimate. This management system is a prototype. It expounds the importance of the building precaution ideal. Because it's a beginning, each estimate item still needs to be improved.

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