On May 12, 2008, a major earthquake occurred in Sichuan, China, which the earthquake calculated to be at the of Micron Log 8.0; caused nearly 70,000 dead, 18,830 were missing, 370,000 injuries, and over 15,000,000 under emergency evacuation and in an immediate demand for shelters. Taiwan, on the other hand, also had been through a major earthquake disaster – Chi-Chi Earthquake. Therefore, to understand clearly earthquake evaluation can help to deal with the disaster in the early stage, assists the decision-maker to acknowledge the level of severity once an earthquake occurs, and is also a guideline for a prompt and accurate decision-making.

This article applies the “National Center for Research on Earthquake Engineering” of “Taiwan Earthquake Loss Estimation System-TELES” as the simulation tool; TELES mainly uses “MapInfo” to present the condition of the disaster. And, cites 1999 ML 7.3 Chi-Chi Earthquake (caused a great number of casualties in Taiwan) and 2008 ML 6.8 Lanyu Earthquake (the biggest earthquake occurred in this year), using these two citations for the evaluation on the scale of an earthquake. Furthermore, this article also applies the Monte Carlo Simulation to implement TELES for the Indefinite Analysis evaluation on the number of casualties. This is to understand the precaution in the early stage of an earthquake, which adopts TELES as a simulation tool on the number of casualties in accordance with the number of hospital bed in Taipei. Using the above all to study earthquake precaution and uncertainty analysis on the number of hospital bed, in support and assist the decision-maker to provide the accurate and prompt decision when disaster occurs.

**Keywords-component:** Uncertainty Analysis; Taiwan Earthquake Loss Estimation System; Monte Carlo Simulation

I. INTRODUCTION

Taiwan's unique geographical environment is vulnerable for natural disasters, such as typhoons and earthquakes. With the rapid development of urbanization, resulting in increased vulnerability of the environment, leads to a trend of disasters in recent years. And, also with the development of public facilities and transportations, population distribution becomes more and more concentrated. As Taiwan is a densely populated country, with buildings gradually developed to high-density and high-level structures, if the recurrence of a similar 921 Chi-Chi earthquake definitely will lead to an even more substantial economic losses and caused a great number of casualties. However, if apply TELES for simulations and have prior knowledge for an immediate response of decision-making preparation and combines with "mutual understanding", thus will be able to minimize losses.

In the year of 2003, the Department of Health Taipei City established a disaster response command center called EOC. The main purpose of EOC is to control manpower when an emergency occurs, and to establish emergency response agencies, as well as interactive communication channels: the evacuation of patients and arrange for shelters. This study adopts two sets of TELES, which it shows the number of casualties and distribution. In the future, this can assist EOC in arranging for hospital beds when disaster occurs, and in preparation for medical resources.

II. OVERVIEWS OF TELES AND SESS

A. TELES

"Taiwan Earthquake Loss Estimation System-TELES", is a set of earthquake loss estimation system for Taiwan, containing research results of different fields and is able to collect all types of data on humanities and natures, which is applicable for types of users. TELES is an application mainly for localization and analysis purposes, which it is developed for integrating geographic informational system, and is the design for individual PC platform. Although, TELES’ analytical framework and evaluation applies from United States of America designed system called HAZUS, but the overall structure and modular design concept of the system is different with the HAZ-Taiwan. TELES and HAZ-Taiwan have absolutely different programming codes. In order to
The objective of TELES is to analyze modules which divided into four parts; potential earthquake analysis, loss estimation on constructional structures, seismic evaluation caused by a second disaster, and social-economic loss estimation. Each module can be broken down into numbers of secondary module, which it is able to simulate earthquake activity under ground vibration intensity, soil liquefaction and probability of permanent displacement, probability of the damaged condition number on general structures, and the extent of the number of casualties and direct economic losses on general structures. However, there is still lack of basic information to carry out a wider range of disaster loss estimation. Nevertheless, current development progress has reached partial goal for loss estimation.

The main objective of TELES early assessment is to meet the needs of all levels of governmental emergency response centers. In a short period of time after an earthquake occurs, we can immediately estimate the ground vibration intensity, soil liquefaction and probability of permanent displacement, probability of the damaged condition number on general structures, and the extent of the number of casualties. If an earthquake has just occurred, focal mechanism and related parameters are not clear that it would have to be carried out in the early assessment of the earthquake. Its major emphasis is on the rapid estimation of earthquake damage distribution and number. Figure 1 shows the numbers of casualties and loss estimation chart for TELES. [2]

B. SESS (Simple earthquake seismic system)

Local governments usually collect ground and structural data for earthquake disaster simulation. In order to gather and organize all the necessary data, we must need labors, sufficient time and funding. When the disaster occurs, unless we are professional engineered staffs, it would be difficult to presume the relevant data. Therefore, the establishment of SESS is mainly to compare the time of the earthquake and all the relevant circumstances of various elements. Anyone can easily complete disaster simulation, instantly. Why established SESS? The goal is to provide effective and useful information on disaster prevention, so that the general public is able to understand the disaster situation based on simulation results. SESS is a reference guide for disaster relief program, and a guideline for general public. [3]

In this report, we have used the seismic value for peak acceleration on surface (PGA). At the time of the earthquake, we can obtain earthquake information (source, size) from the Central Weather Bureau, apply it into formula, and then we can obtain the earthquake PGA values for all regions. The data of the selection on a total of 59 earthquakes with ML = 5.0-7.5, adopt two levels of the geometric mean, as of the shallow earthquake (depth = 0-35 km). This system can predict the life of residents and properties which are directly related to the four-basic disasters; collapsed of structures, the number of casualties, post-earthquake fire, and as well as shelters. In the rate of the calculation for one county, the necessary time it takes is about 10 seconds. Figure 2 shows the numbers of casualties and loss estimation chart for SESS.

III. EXPERIMENTAL METHODS AND PROCEDURES

In order to understand which part of regions has the greatest impact on earthquake casualties in Taipei city, in the first experimental procedure, we focused on 24 coordinates surrounding Taipei city to carry out simulation (ex. Figure 3). Assumed ML of 6.7, and 7.4, set the depth to 10 km, and applied TELES simulation to run a total of 72 times.

In the first experiment (shown in Figure 4–Figure 9) which applied TELES and SESS, we found that in the Eastern and Taipei basin regions usually resulted in casualties. In order to better understand the relationship between the two, the second experiment is conducted for Central and Eastern regions on 35 coordinates. Assumed depth of 10 km and ML of 7.4, as shown in Figure 10 and the result shown in Figure 11.

In the second experimental result of the Central region, whether using TELES or SESS earthquake simulations, we found no casualties in Taipei City. In Eastern region, we found by using TELES simulation the repeatability of longitude within 5 min (about 9.25 KM) is high.

IV. MONTE CARLO SIMULATION

Through the first and second experimental results, we were unable to apply performance function for analysis. Therefore, we applied Monte Carlo Simulation in the third experiment by using random sampling through computer simulation to carry out earthquake simulation on uncertainty and data. Based on the 1999 “921 Taiwan Chi-Chi Earthquake” with ML of 7.3 which caused a great number of casualties, and as well as the June 2008 “LAN-YU Off The Coast Earthquake” with ML of 6.8 which is the biggest earthquake occurred in our country this year, to calculate earthquakes simulation parameters. And due to 2008 “Sichuan Earthquake” in Japan, the standard deviation revised to 0.2 and therefore assumed to be at 0.2 . Assuming average depth of the earthquake is 10 kilometers, standard deviation as 2; average longitude is 121°35'00", standard deviation as 0°2'30"; average latitude is 25°00'00", standard deviation as 0°2'30". Then by using excel random numbering generator and the assumption that the distribution patterns is normal, thus resulted in 100 data, which is from a total of 200 groups (as shown in Table 1). Based on the assumption applied from TELES and SESS simulations on casualties, the data is shown in Table 2 and mapped out Figure 12–Figure 17.

The result of this experiment applied TELES and SESS simulations for the numbers of casualties as the maximum value to explore preparedness of hospital beds when disaster occurs. Therefore, the final analysis of this report is by SESS. Hospital beds in Taipei city is about 22,518 [4]. Based on the statistics of Taipei City Health Bureau at the end of 2007, showed the hospital bed occupancy rate is found to be at 71.81% [4]. If can provide 28.19% of the empty beds for emergency use, according to Figure 18, only 34% of satisfaction that there will be enough hospital beds when earthquakes occur. If in the disaster prevention and relief
program of Taipei city, prepare for healthcare resources to carry out preparedness of hospital beds, then is able to provide 7,791 temporary hospital beds, thus may increase satisfaction to 80%.

V. CONCLUSION

1) Within 12 hours of the Post-disaster, we can refer to the first phase of SESS for casualty data, which is more accurate. In 24 hours after the disaster occurred, we can apply to the second phase of the TELES for estimation on the numbers of casualties.

2) Refer to the first two experiments, the result of TELES estimation is in three sets of data repeatedly within 9 kilometers (1 min = 1.85 km), but SESS only estimates two coordinates repeatedly. Therefore, the accuracy of the first phase of TELES is poor.

3) From the second experiment, we can understand the occurrence of earthquakes in the Central region. Regardless of TELES or SESS, Northern region will not result in any casualties, but Eastern region is different.

4) In the three experiments of TELES, the value of casualties is more conservative. As an example of Taipei basin in the scale of 7.4, SESS estimates 25,000 casualties, but TELES estimates only 952 casualties.

5) On the third experiment, we can understand SESS simulates the scale of an earthquake at the maximum value of 7.5. However, TELES can only simulate at the maximum value of 7.4.

6) As the result of the experiment, SP-TP analysis data is symmetrical.

7) From the Statistics Figure of (SP-TP)/TP, we found that the main statistical outcome is concentrated in the left part.

8) Presently, it estimates 22,518 hospital beds in Taipei City. If does not integrate hospital beds, the average number of empty hospital bed is 6,348 when earthquake occurs. Thus, based on the analysis report, about 34% of confidence is sufficient. On the other hand, if integrates 7,791 temporary hospital beds, estimates to 80% confidence is sufficient.
Figure 5. TELES simulation scale of coordinates in Taipei City (caused by ML of 6)

Figure 6. SESS simulation scale of coordinates in Taipei City (caused by ML of 7)

Figure 7. TELES simulation scale of coordinates in Taipei City (caused by ML of 7)

Figure 8. SESS simulation scale of coordinates in Taipei City (caused by ML of 7.4)

Figure 9. TELES simulation scale of coordinates in Taipei City (caused by ML of 7.4)

Figure 10. Experiment - Assumption of coordinates regions
Figure 11. 2nd Experiment – Assumption of repetition on the result of the data

Figure 12. Earthquake M.L. Scale

Figure 13. SESS Casualty Scale

Figure 14. TELES Casualty Scale

Figure 15. SESS Casualty-TELES Casualty Scale

Figure 16. (SESS Casualty—TELES Casualty)/TELES Casualty
TABLE I. MONTE CARLO SIMULATION – ASSUMPTIONS OF EXPERIMENTAL DATA

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REFERENCES