Disaster medicine center to a big earthquake in TMA – Construction engineering to provide disaster medicine

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ABSTRACT: The 1923 Kanto earthquake in Japan produced a large number of casualties. If a similar quake were hit present day in kanto region, medical functions of hospitals filled with patients would be destroyed with people unable to provide care. As a protective measure against medical facilities damage, the systems of disaster medicine operation center with latest engineering technologies such as a base isolation system (BIS), an interstitial space ceiling system (ISS) and temporary ward system has been developed. These systems serve to prevent damages to medical functions in the event of a big earthquake.

1 PURPOSE

At the time of the Kanto Earthquake of 1923, the Tokyo Metropolitan Area (T.M.A) suffered great damage from the main shock and the aftershocks. Medical facilities were destroyed totally with people unable to provide care in the early stages of the earthquake.

Dr. KAWASUMI of Japan has deduced from the past statistics that there is a 69-years cycle (error margin: 10 years) of big earthquakes in the T.M.A.. The next big earthquake is due any time now.

If a similar severe quake were hit present-day in Kanto region, since medicine as practised in hospitals today uses the latest

![Diagram of International Disaster Medicine Operations Center]

Figure 1. A Proposal of International Disaster Medicine Supporting System

| FIRST AID MEDICAL BASES in suffering districts (The injured is estimated about 900,000) | a. UNIVERSITY HOSPITAL
b. MEDICAL SUPPLY DISTRIBUTION CENTER
a. NECESSARY GOODS DISTRIBUTION CENTER
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>AIR TRANSPORTATION BASES</td>
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<tr>
<td>Tokyo International airport (NARITA) and Helicopter Bases</td>
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<tr>
<td>MAJOR FIVE UNIVERSITIES in the outskirts of Tokyo Metropolitan Area (beds, 3,400)</td>
</tr>
<tr>
<td>LOCAL MEDICAL UNIVERSITIES and MAJOR HOSPITALS (beds, 25,000)</td>
</tr>
<tr>
<td>THE INJURED FROM ABROAD transportation</td>
</tr>
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<tr>
<td>→ : The injured, ← : MEDICAL TEAMS, → : Necessary goods</td>
</tr>
</tbody>
</table>

Table 1. Damages in Kanto earthquake 1923 and forecasted damages in Reemerged Kantou earthquake (Medical facilities)

<table>
<thead>
<tr>
<th>Suffering district</th>
<th>Kantou EQ. 1923</th>
<th>Reemerged Kantou EQ.</th>
</tr>
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<tbody>
<tr>
<td>Human damages</td>
<td></td>
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<tr>
<td>132,000 dead (Tokyo and Yokohama)</td>
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<tr>
<td>150,000 dead and * 265,000 (Injured)*</td>
<td></td>
<td></td>
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<tr>
<td>Hospital building</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buildings were destroyed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collapse will be unlikely</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment function</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Functions were destroyed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment facilities and medical functions will be destroyed.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* From the test calculation by NATIONAL LAND AGENCY, 1988
high technology including complex electronic systems into treatment facilities, the severe damages to various medical systems and functions will be inevitable. (Table 1.)

As a protective measure against these outcomes, a new system to provide disaster medicine and construction engineering has been studied for many years.

2 A PROPOSAL OF INTERNATIONAL DISASTER MEDICINE OPERATIONS CENTER

We estimate the number of the injured about 900,000 by primary and following secondary disasters and all city functions in the T.M.A. would be destroyed. The most effective response to such a mass casualty incident would be to mobilize a large number of ambulances and a large number of rescue teams. A rapid air transport throughout the country as shown in Figure 1. There are major four universities in northern part outskirts of Tokyo and more than 100 hospitals at local universities situated near the local airports.

We propose the construction of an international disaster medicine operations center consist of 1) university hospital, 2) medical supply distribution center and 3) necessary goods distribution center located near the main airport of Tokyo International airport (Narita) as shown in the right side of Figure 1. In the event of emergency treatment at times of major disasters, the information system of the disaster medicine operations center will be switched to the prearranged exclusive code for emergency treatment for processing items such as composition and service records of medical teams and of auxiliary teams, and supply and consumption of emergency medical goods.

3 INTRODUCTION OF BASE ISOLATION SYSTEM (BIS)

Figure 2. A concept of medical facilities for disaster medicine.

Figure 3. Observed acceleration waves at Tokyo Bay earthquake Feb. 2, 1992.

To prevent confusion of emergency treatment activities. The details on these systematization are described in another report of "T. Tanahashi and K. Yomaru: A new system to provide disaster medicine" shown in references.

After the earthquake, by and by, city functions such as electric service, traffic system and many other things will be started to recover, the injured will be also started to transport back to the T.M.A. Functions of hospitals expect to be alive.

We want to propose a new construction engineering of base isolation system (BIS) for hospital building to be alive in the event of major earthquake. Figure 2 shows a concept of main medical facilities in the international disaster medicine operations center.

Since all the major hospitals within the T.M.A. have been constructed to resist earthquakes and fires, collapse of such buildings is highly unlikely. Damage, however, to examination and treatment equipments and functions of various devices will be inevitable.

Base isolation system made of laminated rubber bearings and dampers converts seismic motion into gentle movements with longer periods and reduces seismic forces.

Figure 3 shows "Tokyo Bay earthquake, M=5.9, Feb. 2, 1992" observation data on base isolated building, ordinary building and free field, which observation points are shown in Figure 4. The acceleration at the
Figure 5. MBIS and ISS for operation ward.

Figure 6. MBIS and ISS for diagnostic room.

Figure 7. Estimation of response at BIS and MBIS building and ordinary building excited by ground motion.

The roof of isolated building was about 1/5 of that at the free field. The system has been adopted at many buildings in Japan.

Figure 5. and Figure 6. shows a proposal concept of multiple base isolation system (MBIS) enhanced isolation effects. This system can be divided into three levels of a) base isolation for principal medical wards, b) floor isolation for operating rooms and diagnosis and treatment rooms and c) equipment isolation for microsurgery table.

These isolation systems would be able to applied to the medical principal wards such as, emergency treatment centre, examination

Figure 8. Details of ISS (Height of ISS: 1.9m)

Figure 9. Details of ISS (Height of ISS: 2.4m)

Figure 10. Comparison of floor hight (examination ward and operating ward).

ward, information center, image diagnosis center, and bed wards.

Given these modifications in building, we estimate the response accelerations of less than 30 Gal at the principal rooms exciting by earthquake ground motion of 300 Gal, in opposition to more than 500 Gal at ordinary building without base isolation system as shown in Figure 7.

4 INTRODUCTION OF INTERSTITIAL SPACE CEILING SYSTEM (ISS)

Ordinary ceiling space in hospitals has about 1.2 m in height and is difficult to
stand. Interstitial space ceiling system (ISS) has large space of 1.9 m to 2.4 m in the ceiling as shown in Figure 8, and Figure 9. The space of 1.9 m is uncomfortable standing room and the 2.4 m is comfortable one. In case of 5 stories examination ward and operating ward, as shown in Fig 10, total height of building will be about 19.2 m for ordinary building, 24.1 m, 26.6 m for ISS buildings.

The space with ISS serves to repair service systems of buildings in the event of major earthquake, and also, renovate into latest information systems and make growth service life into intelligent hospital systems. Following wards will be equipped with ISS: image diagnosis center, information center, outpatient ward, emergency treatment center.

5 INTRODUCTION OF EMERGENCY TEMPORARY WARD

Figure 11 shows a concept of emergency temporary ward (about 1,000 m²) constructing in the site of major hospitals. It functions as a sports hall (Figure 12) or a lecture hall in normal time and will convert into temporary treatment ward in the event of major disaster occuring as shown in Figure 13 to Figure 14. Accomodations are 100 beds buried into the wall, medical oxygen, compressed air system, piping system for power supply and necessary goods.

6 CONCLUSION

This proposal establishes a disaster medicine operations center near the designated airport at the periphery of Tokyo metropolitan area (T.M.A.), and develops protective construction engineering for medical functions such as base isolation systems to prevent damage, interstitial space ceiling
systems to serve easy repairs of service equipments and emergency temporary ward functioning as a sports hall in normal time. As a result, emergency treatment functions would be able to continue unimpeded at disasters.

REFERENCES

Takahashi, I. & Yomaru, K., 1992. Disaster medicine operations center to a big earthquake in T.M.A.-A new system to provide disaster medicine-. Proc.10thWCEE, Madrid, Spain.