HOUSING RECONSTRUCTION PROCESS OF THE GREAT HANSHIN-AWAJI EARTHQUAKE DISASTER – ID 1554

K. Koshiyama, DRI, Japan

Many disasters caused extensive damage to some cities in the world. In most cases many housings and public buildings had been rebuilt at same or distant locations, so physical environments and social conditions were changing and developing step by step. In the process the urban areas were transformed into new living spaces for survivors. The case of Hanshin-Awaji area attacked by the large earthquake in 1995 is valuable for learning lessons in considering a disaster recovery program. This study reported the transformation for ten years to examine the urban reconstruction program. First, we clarified characteristics of basic condition in damaged areas by gathering and analyzing of national population census in 1990, 1995, 2000 and public statistics of local governments. Second, we extracted distinctive blocks from damaged areas through urban whole recovery process by factor analysis of statistic data, and grasped the changing process of physical environments by geographic analysis of digital map data, aerial photographs and so on. Finally, we reviewed a series of recovery policies and showed the relationship between public planning and the urban transfiguration. We could have two main conclusions in this study. One it is important to make a disaster recovery plan for providing housings with due consideration for the effect on the urban transfiguration, especially of living environments, the other it is necessary to develop urban recovery methodology for a new safety city.

AN INVESTIGATION INTO OPERATIONAL CAPACITY OF SPECIAL STRUCTURES FOR CRISIS MANAGEMENT AFTER THE DECEMBER 26, 2003 BAM EARTHQUAKE – ID 1558

H. Afshin, Sahand University of Technology, Iran (Islamic Republic Of)

A powerful earthquake occurred in Bam city, south-east of Iran on 26 December 2003. About 70% of the city buildings were destroyed. The majority of the crucial essential buildings for crisis management such as hospitals, fire stations, telecommunications centers, governor office, and aid-supplying depots were so heavily damaged that could not be applied in the rescue operations. In this study the structural behavior of these buildings and its effects on their operational capacity after earthquake are investigated. The seismic performance of these buildings is discussed and their strength and weakness points are highlighted. Based on the results of this field investigation, it can be concluded that inaccurate detailing, use of weak materials, thick roofs (for thermal insulating in hot weather of region), lack of suitable lateral-load-bearing systems (due to absence of experience of strong earthquake in the past 2000 years in region), weakness of joints between structural elements, irregular plan, poor workmanship and etc. were reasons for damages to many of these buildings. This research is an attempt to provide an opportunity to raise awareness of the importance of seismic safety of crisis management special buildings for post-earthquake rescue operations and highlights the necessity of seismic retrofitting of these buildings for risk reduction in Iran as well as in other hazard-prone countries.

THE 21ST OF MAY 2003 EARTHQUAKE EFFECTS ON THE ENVIRONMENT OF ALGIERS – ID 1560

A. Zerzour, Civil Engineering Faculty- Algiers University, Algeria
H. Zelloum, Civil Engineering Faculty- Algiers University, Algeria
M. Chabaat, Civil Engineering Faculty- Algiers University, Algeria

An earthquake of a magnitude Ms= 6.6 (according to CSEM) and Ms=6.7 (after NEIC) on Richter Scale hit the city of Boumerdes and its surroundings on May 21st 2003 at exactly 19:44 pm. Boumerdes city is located on coast line approximately 50 km from Algiers, Capital of Algeria. According to Harvard Center, the deformation at the level of the hypocenter is a reverse fault (direction NE – SW). On the basis of the seismic movement, the fault has the length of 15 to 20 km and a displacement of the order of 1 meter. Then, the hypocenter is considered as being superficial (approximately 10km). The epicenter zone is in the area of Boumerdes which is located at approximately 50km from Algiers. All the above information of earthquake has been reported by the Research Center of Astronomy, Astrophysics and Geophysics (CRAAG- ALGERIA). During the earthquake, 2300 human lives are lost, 9000 persons are injured and more than 3000 disappeared. One the other side, the damage of rural houses are estimated to be: among 10, 000 structures or rural houses visited just after the earthquake's hit, one noticed that 3500 are classified as requiring slight repair (70%) and some others presenting no damaging (30%). Besides, 3800 are classified as requiring a deeper evaluation of repairing and strengthening (36%) and finally, 3000 completely classified damaged and should be demolished (50%).

Key Words: Earthquake, Algeria, Fault, damage evaluation, Strong motion records, seismic intensity, accelerograms, magnitude estimation, isoseismal map, Disaster management, seismic risk.

LESSONS FROM BAM EARTHQUAKE: SEISMIC BEHAVIOUR OF BUILDING STRUCTURES DURING THE EARTHQUAKE – ID 1587

A. R. Manafpour, Halcrow Group Limited, UK

The Bam earthquake on 26 December 2003 with magnitude Mw=6.6 destroyed most of the city of Bam in Iran and nearby villages, and killed more than 26,000 people. The earthquake was by far the most devastating earthquake in the history of the region around Bam. After the earthquake the author undertook a field investigation and visited the affected area. The paper studies the structural damage on traditional as well as modern building structures during the earthquake. The dramatic scale of the casualties associated with a relatively small affected region highlighted the particular vulnerability of other cities in the earthquake region.

The paper considers different types of the buildings in the earthquake affected area including: Adobe, masonry, steel and reinforced concrete structures with some examples demonstrating the response of each type of the buildings. Discussion of the structural behaviour is given with reference to existing seismic design codes and construction practice within the region. It is concluded that as a considerable number of buildings in central and eastern provinces of Iran, more specifically in villages, are built of mud-bricks and will not resist similar magnitude earthquakes. Due to specific materials and construction forms special strengthening procedures needs to be developed. A good majority of the non-traditional buildings are built of masonry or a combination of masonry and steel without any specific seismic considerations and are vulnerable to earthquakes. An active retrofit and renewal strategy should be formulated to encourage the owners to undertake retrofitting.

GROUND MOTION CHARACTERIZATION IN THE MURCIA REGION (SE SPAIN) – ID 1759

J. M. Gaspar-Escribano, Universidad Politécnica de Madrid, Spain
B. Benito, Universidad Politécnica de Madrid, Spain
J. García-Mayordomo, Universidad Politécnica de Madrid, Spain

After fifty years of minor seismic activity, the Region of Murcia has been the focus of the three last significant earthquake series in Spain: the 1999 Mula, 2002 SW Bullas and 2005 La Paca series. These have been the last damaging earthquakes in Spain, reaching maximum intensities of VI and VII and causing significant economical losses but fortunately no casualties. Several factors contributed to the observed damage: buildings characteristics, local site effects due to the presence of soft soil and the severity of the seismic shaking. In this work we analyse the significance of ground motions. Ground-motion records correspond to large epicentral distances so they cannot be used to assess ground motion effects at damaged sites. However, the normalised spectral shapes are compared to the design spectral shapes used to construct the Spanish Building Code (NCSE-02). A systematic exceedance of

NCSE-02 spectral shapes by recorded spectral shapes for short periods is observed. This is corroborated in the epicentral areas where modelled spectral shapes also exceed their NCSE-02 partners for short periods. Implications of this result on seismic hazard in the Region are analysed. We show that the uniform hazard spectra for the 475-year return period can be decomposed into two response spectra, corresponding to short- and long-period spectral accelerations. The most significant hazard contribution comes from the short-period component. Hazard deaggregation shows that the larger hazard contributions correspond to moderate events originated at local sources. The corresponding specific response spectra are very similar to the uniform hazard spectra and exceed the corresponding NCSE-02 response spectra for short periods. We conclude that the response spectra specified in the NCSE-02 Code for the return period of 475 years may need to be revised in future versions of the code.

A RESEARCH ON THE EVALUATION OF UNDERLYING RISK FACTORS IN THE AREA – ID 1788

T. Shigaki, osaka city university, Japan
E. Ikuta, osaka city university, Japan
M. Miyano, osaka city university, Japan

The 1995 Hyogo-ken Nanbu Earthquake (an inland earthquake) was the falling plumb down of the large metropolitan area, and made enormous damage in Kobe area, in Japan. In the physical damage, the complete collapse building exceeded 100,000 and 5502 persons were killed directly by this earthquake. That was the biggest sacrifice after the World War II;in Japan. Approximately above the half of victims, especially the dead person was the elderly over 65 years old and it showed the same tendency as natural disasters in the past. On the other side, the daily disaster which occurs in the everyday life exists in our life environment in addition to the natural disaster to attack us suddenly as earthquakes. There are many accidents in dwellings those belong to the daily disaster, and according to such accidents over 10,000 persons lost their lives every year. An overwhelming majority of the casualty due to the daily disaster is also the elderly over 65 years old. Such tendency is in common with the natural disasters. It is pointed out that the unexpected accident which represents a daily disaster occurs in relation to the attribute of people and buildings in the area. In aged society, Japan, it is very important to be clarified the influence of the elderly people ratio to underlying risk in the area. In this research, we grasped the status of the daily disaster in the primary and the junior high school unit which is the base unit of the insurance human services by the public administration in Osaka, at first. Secondary, we analyzed the relationship between the regional characteristics and the investigation results at first step. Lastly, we could clarify underlying risk factors in the area according to the evaluation above mentioned.

FRAMEWORK OF BIOMECHANICAL MODELING FOR EVALUATING HUMAN BODY DAMAGES CAUSED BY COLLAPSED BUILDINGS IN GREAT EARTHQUAKE – ID 1815

E. Ikuta, Osaka City University, Japan
M. Miyano, Osaka City University, Japan
F. Nagashima, Tokyo Metropolitan University, Japan
J. Ozaki, Tokyo Metropolitan University, Japan

The 1995 Kobe Earthquake struck the southern part of Hyogo prefecture catastrophically and brought 5,502 immediate victims (not included the related death) and 10,683 serious injured. This number of casualties is the greatest in recent disasters in Japan. According to our comprehensive database about cause of casualty and building damage in the Kobe earthquake, it was found that the typical direct cause of death was suffocation due to thoracic compression, while the most of serious injured persons had a bone fracture at the region of abdomen, lumbar and thigh. This paper presents a framework of biomechanical modeling and evaluation method for impact and compression damages of human bodies caused by collapsed buildings in great earthquake. The final goal of this research is to provide high-precision virtual dummy for disaster mitigation by making use of the most advanced knowledge such as biomechanics and kinesiology. First, anatomy geometric shape data (CAD data) are converted into FE model data by translating through the intermediate EXCEL data. Model meshing and element forming are carried out. At this time, minute elements are eliminated for reducing CPU requirement. At next phase, bone crashing/bending simulation test and muscle compression test are conducted for finding physical properties of each element. As a typical cause of death, thoracic compression processes is simulated and the results is compared with CT-scanner experimental results. For a case of serious injury, we examine load carrying capacity of the muscle at the thigh region by both experimental and analytical study. Using the thigh model, damages under some cases of overturned furniture (type, material, shape of impact face) are investigated. Consequently, we establish a framework of biomechanical modeling procedure and evaluation method for human damage. The results of this study are available not only for safety evaluation but also for education on residents.

THE ZAKYNTHOS (W. GREECE) SEQUENCE OF OCTOBER 2005 - APRIL 2006 – ID 1906

C. Papaioannou, ITSAK, Greece

A sequence of moderate magnitude earthquakes occurred south of Zakynthos Island (W. Greece) in April 2006 with magnitude of the strongest earthquake Mw5.7. An earthquake with magnitude Mw5.6 occurred at the same area on October 2005. In the present paper the space time distribution of the earthquakes for the period October 2005-April 2006 are presented. It is shown that within one month after the October 18, 2005 earthquake the seismicity rate was at the level of the background seismicity and on April 3, 2006 another sequence started at the same with the same type of faulting. All the available fault plane solutions show that the strongest of the earthquakes are associated with a low angle thrust fault with NW-SE direction. The earthquakes were strongly felt at the town of Zakynthos where minor damage were observed mainly to brittle structures. ITSAK operates at this area a strong motion array. The maximum recorded PGA was 22%g. The results of the strong motion data recorded at the broader area of Zakynthos Island are shown and discussed.

SEISMICITY OF SOUTHERN THAILAND AFTER THE 26 DECEMBER 2004 ANDAMAN SUMATRA EARTHQUAKE – ID 1922

S. Dangmuan, Prince of Songkla University, Thailand
W. Lohawijarn, Prince of Songkla University, Thailand
H. Duerrast, Prince of Songkla University, Thailand
P. Nuannin, Prince of Songkla University, Thailand
P. Yongsiriwith, Songkhla Rajabhat Institute University, Thailand

After the magnitude 9.3 Andaman Sumatra Earthquake on 26 December 2004 and the subsequent aftershocks questions emerged about the impact of this major earthquake on fault zones in Southern Thailand, especially Klong Mauri (KMF) and Ranong Fault Zone (RFZ). In January 2005 the Geophysics Group installed short period seismographs in the provinces of Phuket, Krabi, PhangNga to monitor the seismicity. Over a period of about six months 157 earthquakes with Ml $<$ 2.5 were recorded in an area between longitude 7.25 N to 10.12 N and latitude 97.26 E to 99.69 E. Several of these earthquakes are aligned parallel to the NE-SW trending fault zones, KMF and RFZ, indicating that they were seismically active; others occurred in clusters. Before the 26 Dec 2004 earthquake the subduction zone in the Andaman area was locked and subsequently the Eurasian Plate with Thailand was moving towards East. The major earthquake unlocked this part of the subduction zone and lead to crustal deformation. This resulted to a westwards movement of the general Eurasian Plate in this region, documented by GPS measurements (Vigny et al, 2005). However, the greater area around Phuket and PhangNga showed significantly higher movement rates to the West than areas further North or South. A possible explanation is that the existing faults in the Thai peninsula were activated by the crustal deformation of the