ABSTRACT

The 2002 Molise Earthquake had a devastating effect on the town of San Giuliano. It caused tremendous structural damage and loss of life, rendering many buildings unsafe for occupation. The reconstruction of the town is being planned and issues regarding the soil structure interaction and the retrofitting of masonry buildings are of high interest. This paper summarizes the observations made by the Tri-Center Field Mission Team during the earthquake reconnaissance visit of October 2003 in Italy, supported by three U.S. Earthquake Research Centers; MAE, MCEER, and PEER.

BACKGROUND

Like so many regions of this world, the country of Italy has suffered from a vast history of high seismicity. The many active faults within the region have been the source of several significant and devastating earthquake events (News 2003). The most recent significant seismic event took place at 11:32 A.M. (local time) on October 31, 2002. The moment magnitude 5.7 earthquake hit the region of Molise, which is located in the southeastern part of the Italian peninsula. The location of the epicenter was about 220 km southeast of Rome, see Figure 1. Following this main event, an aftershock of the same magnitude (Mw 5.7) occurred the next day in the same region. The epicentral distance between the two events was roughly 10 km. Historically, the inland Appennines area and Gargano promontory have both been regions of intense and well documented seismicity. However, both of the major Molise earthquakes appeared to result from a 20-25 km E-W rupture along a predominately strike slip fault in the relatively inactive transition zone between the Appennines and Gargano promontory.

Due to the low seismicity of the region, seismic recording stations in the epicentral area were few and far between. The closest seismic recording station was about 27km southwest of the epicenter. At this station, the peak ground acceleration recorded from the main event was about 0.02g while the largest recorded PGA was about 0.07g at the Lesina Station, roughly 40km northeast of the epicenter. Despite the relatively small ground motions recorded from the main shock, the earthquake was felt over a very large area and resulted in fairly widespread damage to 50 villages. A total of 30 people were killed, 27 of who were children caught within a collapsed school in town of San Giuliano (Dusi 2003) (Team 2003).

The 2002 Molise earthquake has ignited interest by people worldwide. As with any tragic seismic event, much consideration and time has been invested in an attempt to understand the causes of damage as well as identify necessary structural changes required such that future disaster can be prevented. On October 17, 2003 a small group of students representing the three U.S. earthquake engineering research organizations visited the town of San Giuliano to survey the damage experienced by the 2002 Molise earthquake.

OBJECTIVES

- To assess the social impact and structural damage inflicted by this earthquake
- Understand and compare the differences in building construction, local design codes, and retrofit techniques utilized in Italy

BUILDING SUMMARY

The town of San Giuliano di Puglia, shown in Figure 2 below, was originally a medieval village dating back to 1000 (Arato 2003). It was established on the top of steep sloping hills for protection. The building construction of the town ranged from older, medieval stone buildings and churches to new concrete structures.

BUILDING PERFORMANCE

The town of San Giuliano di Puglia, where the highest macroseismic intensities were observed, is a town of about 1100 people in a small rural region in the south eastern part of the Italian peninsula. Ultimately, the large structural damage experienced within the town was a result of several things such as forward directivity effects, large ground motion amplification in the local soil, and poor building construction. In San Giuliano, the building types are significantly different in the medieval and the new parts. The older buildings are usually located on the rock formations, while the newer buildings are often on soft soil. The older buildings have stone bearing walls and small and far apart openings are often shown in the facades. The first floor is often vaulted either in stones and mortar, or bricks of different types. Better construction practice and firm soil condition make the older buildings perform better than the newer buildings. Some of collapses of the older buildings occurred in buildings that were abandoned without maintenance.

According to field investigations on damages and collapse of building structures as shown in Figure 3, there is need to define new strategies for earthquake protection of buildings. - It is desirable to refine seismic zone according to the most recent studies and minimum seismic design should be specified in regions of low to no seismicity.
- The quality of construction material and workmanship should be carefully controlled.
- The large percentage of openings in the walls and extremely irregular configurations, which lead to soft- story mechanisms, should be avoided.
- The addition of new storeys and interventions replacing the existing members should be carefully decided.
- The assessment and retrofit of existing buildings with poor seismic resistance should be promoted in order to prevent heavy damages.

RETROFIT MEASURES

The successful retrofit strategy requires full understanding of the expected response mechanisms of the retrofitted masonry structures and how retrofit measures can alter the complete building response. When using new techniques and materials experimental research has to be carried out before, not only on the mechanical behaviour but also on the physical and chemical compatibility with the existing structure and materials. The selected method must be consistent with aesthetics, function, and the strength, ductility, and stiffness requirements.

CONCLUSIONS

The observations made in this paper indicate that there are several issues that contribute to the amount of damage experienced after the Molise earthquake. Poor quality of materials and construction practices appear to be the main contributors. Although the magnitude of the earthquake was not severe, it caused extensive damage that will take a significant amount of time to restore. In addition, seismic design criteria must be adopted for new construction practices, to prevent similar outcomes in the future.

ACKNOWLEDGEMENTS

The Field Mission in Italy was supported in part by the Multidisciplinary Center for Earthquake Engineering Research. The authors wish to thank Mr. Alberto Dusi and members of the EERI Earthquake Reconnaissance Team for their contributions.