

SOUTHERN ITALY EARTHQUAKE, NOVEMBER 23, 1980

Reconnaissance Summary

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Introduction

A Swiss reconnaissance team, consisting of earthquake engineers and seismologists, spent the week of December 15 to 21, 1980 in the region most severely damaged by the Southern Italy earthquake of November 23, 1980. The team members were:

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- J. Studer, Dr.sc.tech., Geotechnical Engineering Department,
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The purpose of the trip was to have a firsthand eyewitness report of the effects of the earthquake on structures, lifelines, and terrain. Special attention was given to structures which are also found in Switzerland. A damage survey in various places allowed a first assessment of intensities on the MSK-scale. This articles presents a summary of the extensive data and the overall impressions of the damage, which were obtained by the team in the region most severely damaged by the earthquake.

In Italy the team established contacts with the Geophysical and Geological Engineering Department of the University of Bari, the Seismological Observatory in Ercolano (Osservatorio Vesuviano, Ercolano, Napoli), and the CNEN (Comitato Nazionale Energia Nucleare), which also operates a strong motion network in the area affected by the earthquake.

The authors are thankful for the assistance of the numerous individuals in these organisations who were very helpful in providing valuable information. In particular, the help of Prof. G. Panza from the Geophysical Engineering Department of the University of Bari, who helped in organizing this trip is appreciated. The financial support of the Swiss Federal Institute of Technology, the Firm Basler & Hofmann and the Swiss Reinsurance Company is acknowledged.

Seismological Aspects

On November 23, 1980 at 19.34 local time the Southern Italian provinces of Basilicata and Campania were shaken by a strong earthquake of magnitude 6.8 on the Richter scale. The epicenter of the quake, located by the Istituto Nazionale di Geofisica in Rome, had the coordinates 40.81 N and 15.38 E (see Fig. 1) and a focal depth of 15-20 km. A series of aftershocks followed the main shock, whereby the twelve strongest in the 7 days afterwards reached magnitudes between 4.0 and 5.0 and gave rise to further damage. A preliminary investigation of the recorded seismograms showed that the earthquake was caused by a normal fault movement. The main (tensile) stress was in a SW-NE direction. The epicenter was situated in a seismically very active zone of Southern Italy, which follows the strike of the Appenines and bends in the region of the epicenter towards the south to the Tyrrhenic Sea, where the focal depths of earthquakes may be as great as 400 km.

Fig. 1 shows a first assessment of the distribution of seismic MSK-intensities, based on our own observations and supplemented by information from the Osservatorio Vesuviano in Naples. Shown are in Roman numerals MSK-intensities for selected locations and general isoseismal lines. For the purpose of determining MSK-intensities at specific locations the team used a new damage survey sheet issued by the Swiss Federal Earthquake Service. With this survey sheets it was possible to correlate different kinds of damage with typical building structures, evaluate the results with respect to the MSK scale, and establish average intensity values.

The two regions with the highest observed intensities (IX on the MSK-scale) are in the area of normal faulting. The location of the normal fault was de-

defined by the large number of measured aftershocks and by analysing the data from the surrounding seismograph stations. The worst hit areas in the epicentral regions are amongst others S. Angelo dei Lombardi, Conza di Campania, Lioni and Laviano. The epicenter is about 5-7 km north of Laviano. The area with the greatest amount of damage stretches from Avellino to Potenza in the E-W direction and from Grottamindarda to Salerno in the N-S direction, covering an area of approximately 3000 km². Within this area average intensities of VII or more were encountered. However, tremors were felt as far away as in Northern Italy, some 700-800 km from the epicenter.

Geological-Geotechnical Aspects

The earthquake zone lies in the region of the Appenine mountain range. Southwest of a line Avellino-Castelgrande, the rock formations are predominantly limestone of the Trias and Jura, while north of this line the countryside is hilly with recent pliocene and pleistocene sediments. In many places the landscape relief evidences old slides, some of which were reactivated by the earthquake.

Especially spectacular were two slides near San Fele and one near Calitri. All three were more than 500 m wide and up to 1.3 km long. The largest slide movement of nearly 150 m was observed at one of the slides near San Fele. The buildings in the slide area were completely destroyed. The greatest damage to both old and new buildings was caused by the slide which affected large parts of the town Calitri (see Fig. 2). However, the damage caused directly by ground shaking in this town was of minor importance. The breaks in the ground along the different sliding zones in the upper part of the town exhibited both vertical and horizontal displacements from 50 cm to several meters.

Rock slides occurred mainly in the limestone outcrop formations southwest of the line Avellino - Castelgrande, as would be expected based on the geomorphological situation mentioned above. Although extensive rock slides were not observed, small to medium size local rock falls-especially in the epicentral region- were often encountered.

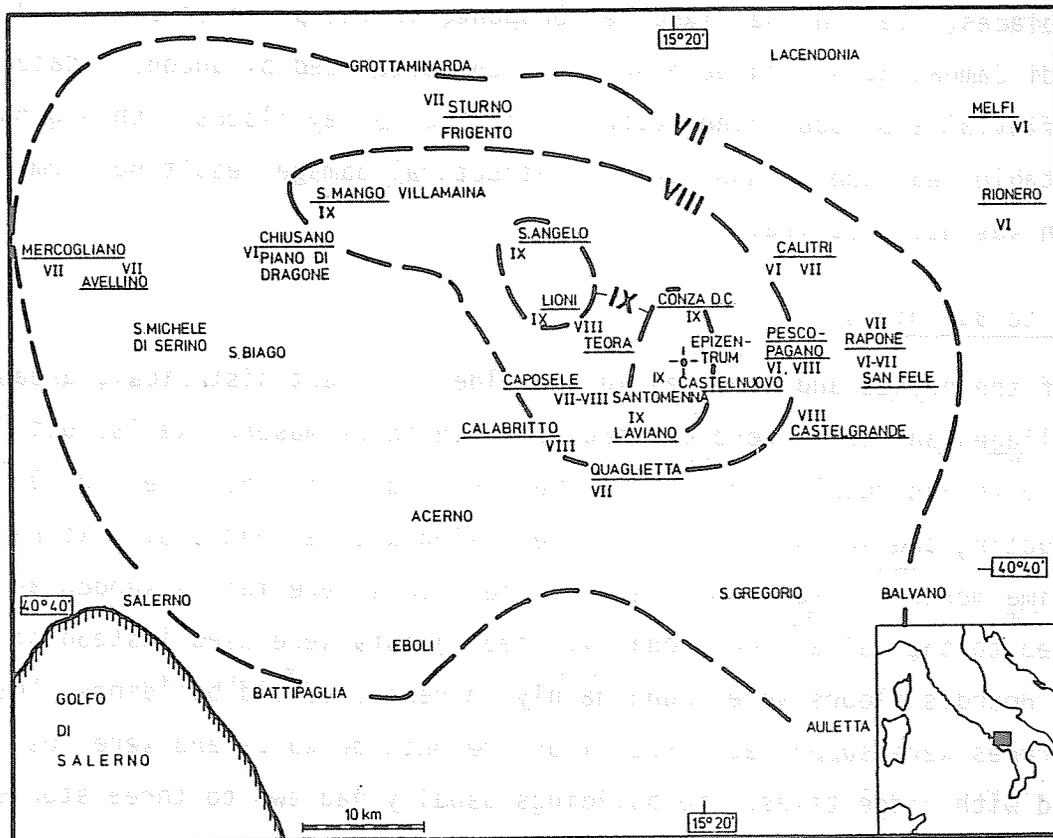


Figure 1 - MSK-Intensities for Selected Locations and General Isoseismal Lines in Epicentral Region Based on Data from Different Sources.



Figure 2 - Slide in Calitri with Damage to Road

Limited soil liquefaction effects (cracks and sand boils) were observed at three places, i.e. in the Piano del Dragone, in the plain of Lioni and near Conza di Campania. All three places are characterized by unconsolidated, alluvial (fluvial and lacustrine) deposits in the valley floors with a ground water table near the ground surface. Structural damage resulting from liquefaction was not observed.

Damage to Buildings

Most of the houses and churches in the older, in part historical, areas of the villages and towns were constructed with thick masonry walls, utilizing large rocks and rubble stones from the surrounding fields (see Fig. 3)*. When constructing the walls, the voids were filled with a sand-clay mixture, a weak lime mortar or sometimes cement. The floors were mainly wooden and seldom tied to the walls. Occasionally, steel joists were used instead of wooden beams. Hourdis floors were found mainly in renovated old buildings. The roof structures were supported directly on the outside walls and were mostly covered with ridge tiles. The buildings usually had two to three stories.

Many of these buildings did not stand up to an intensity VII and were either completely or partially destroyed, which is one of the reasons for the many casualties in this earthquake. Due to the closeness of the buildings in the old community centers, the escape ways were blocked with fallen material, hence impeding the rescue and clearance work. Especially affected in this way were the communities situated on hilltops, e.g. Laviano, Conza di Campania, San Angelo dei Lombardi, and San Mango Sul Calore.

Newer residential and office buildings were typically constructed as reinforced concrete frame structures (see Fig. 4). The building materials used to fill in the frame structure and to construct the walls of lift shafts and staircases were in general hollow clay tiles (exterior and interior walls with space in between), hollow concrete blocks, or occasionally calcareous tufa blocks. The floors and the gable-shaped roofs were built either in reinforced concrete or more often in the Hourdis form of construction (prefabricated concrete beams with clay tiles covered with a concrete layer).

*[Ed. Note: Figures 3 through 6 have been deleted because of duplication in the forthcoming NRC-EERI Reconnaissance Report.]

The extent of damage varied considerably depending upon the intensity. For low values (VI, VII) only insignificant damage to the structure itself was observed. Cracks in the infill and partition walls accounted for most of the damage. This was particularly the case for taller buildings which often had fewer stiffening partition walls because of business use of the first story. Damage in these buildings was mostly confined to the lower stories.

For higher intensities (VIII, IX) the infill and partition walls were largely destroyed (see Fig. 5). In addition, sizeable damage to the load carrying structure was often observed, which, in extreme cases, led to the collapse of the structure. The damage was also greatly influenced by the quality of construction work (concrete and steel quality, construction details, stiffness relationships, symmetry of buildings, etc.). In certain places unfavorable interaction effects between the ground and the building may also have contributed to the damage.

Masonry buildings constructed with calcareous tufa stones or hollow concrete blocks were encountered less frequently, and exhibited similar but somewhat lighter damage than the concrete frame structures. Observed were typically X-shaped shear cracks between the wall openings, falling out of wall sections at corners of buildings and vertical cracks above windows. The only steel skeleton building observed to have suffered damage was in Avellino (intensity VII), where the damage was restricted to burst window panes. Water towers, which mostly consisted of reinforced concrete frames about 25 m high, suffered only mild damage.

Damage to other Civil Engineering Structures

The damage to highways was generally light. Complete closure of roads due to damage caused by the earthquake was seldom. However, in the epicentral region settlement of the embankment fill near bridge abutments, water culverts and underpasses caused differences in road levels of up to 40 cm. These places were provisionally repaired immediately after the earthquake by dumping fill material in the form of ramps. Where roads were on embankments, wide cracks could be observed in the road pavement in the center of the road (see

Fig. 6) as well as along the side of the road. This damage was most likely brought about by instable conditions in the underlying embankment. In slide areas the roads were frequently heavily damaged and sometimes no longer passable (see Fig. 2).

With few exceptions both old and new bridges withstood the earthquake with no or only minor damage. Older bridges were mainly constructed as masonry arch bridges and sometimes showed cracks in the arch or the abutment. The modern multiple span bridges were constructed of prefabricated reinforced or prestressed concrete beams (simple beams between supports). Damage to these bridges was very light. No damage was observed on new concrete retaining walls, which sometimes were several meters high. In three railway tunnels in the epicentral region only occasional surface damage to the stonework lining was observed. These effects were more evident near the portals. Two small embankment dams situated on the periphery of the epicentral region, as well as one now in construction near Conza di Campania, showed no damage.

[Ed. Note: My structural consultant remarks that these reports do not clearly and adequately express the extent of the structural deficiencies due to:

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