A first geotechnical assessment of recent Patti earthquake (Sicily)

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A FIRST GEOTECHNICAL ASSESSMENT OF THE RECENT PATTI EARTHQUAKE (SICILY)

UNE PREMIERE EVALUATION GEOTECHNIQUE DU RECENT TREMBLEMENT DE TERRE A PATTI (SICILE)

EINE GEOTEKNISCHE SCHÄTZUNG VON DEN UNLÄNGSTLICHEN ERDBEBENS BEI PATTI (SIZILIEN)

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Abstract

On Saturday 15th April 1978, at about half an hour after midnight, a 5.4 magnitude earthquake occurred near Patti, making 312 houses uninhabitable and 712 people homeless.

On the basis of instrumental data the maximum ground acceleration at Patti was 0.14g, according to the attenuation law for Eastern Sicily established by Costa and Maugeri.

Old masonry houses collapsed and small landslides, induced by the earthquake, were noted. The new concrete building built on fissured clay were apparently damaged on the buffer walls only.

Resumé

Samedi, le 15 avril, envers minuit et demi, un tremblement de terre, de la magnitude de 5.4, s'est produit près de Patti, avec le résultat que 312 maisons etaient rendues inhabitables et 712 personnes n'avaient plus une maison à eux.

Sur la base des informations instrumentelles, la plus grande accéleration de sol a Patti a été 0.14g, selon la loi d'atténuation pour la Sicile orientale établie par Costa e Maugeri.

Les vieilles maisons en pierre se sont ecroulées et de petits éboulements, produits par le tremblement de terre, ont étés remarqués. Il parait que les nouveaux bâtiments en beton, construits sur l'argille fissurée, ont reçu des dégâts seulement sur les murs de résistance.

Zusammenfassung

Am Samstag, 15 April , ungefähr eine halbe Stunde nach Mittenachts, ist ein Erdbeben, von der Magnitude 5.4, in der Nähe von Patti geschiehen , dass 312 Häuser unbewohnbar und 712 leute heimatlos gemacht hat.

Auf der Basis des instrumentalisches Angaben, die höchste Bodenbeschleunigung war 0.14g, der Verdünnungs Regel für Ost Sizilien, von Costa und Maugeri fortgesetzt, gemäss.

Alte Steinhäuser sind zusammengefallen, und kleine Erdrutsche,vom Erdbebens verangelassen, waren bemerkt. Die Gebäudeschäden den neuen Betongebäuden, auf gespalteten Ton gebaut, waren anscheinend nur an den Stossmauern.

I. DESCRIPTION OF THE EARTHQUAKE

On Saturday 15th April 1978, at about half past midnight (local time), a 5.5 magnitude earthquake occurred in the Aeolian Islands between Lipari and Vulcano, opposite Marina di Patti, a small coastal township in the Commune of Patti (fig. 1).

The main shock was followed by a series of shocks; the largest, having a magnitude between 4.0 and 4.2, occurred on 16th (3 shocks) and 24th April (Istituto di Geofisica dell'Università di Messina , 1978). All the epicentres were located in the sea opposite Patti at a depth ranging between 15 km and 18 km.

Six people were indirectly killed by the earthquake: five of them , in the cities of Messina, Palermo, Patti, Gioiosa Marea and Sant'Angelo di Brolo, died of heart failure, while the sixth was killed in Palermo by a car as he fled from his home.

The worst damaged city was Patti, with 312 houses rendered uninhabitable and 712 people made homeless. Next came Castroreale and the Aeolian Islands where the church with its bell tower suffered severe damage. Also on Lipari 200 people were made homeless.

Landslides, induced by the earthquake, occurred at Capo Calavà and the February 78 landslide at Naso moved again during the earthquake.

The instrumental data now available consists of seismographs recorded at the University of Catania and a seismoscope amplitude recorded at the "Osservatorio" of the Collegio Pennisi at Acireale. The strong motion instruments at the University of Messina did not record any signals because they were not sufficiently sensitive.

2. ENGINEERING CHARACTERISTICS

The earthquakes appeared to be of tectonic origin and several faults are present in the region, as sketched schematically in fig. 2. It is interesting to note the presence of a fault passing by Mt Etna . through Patti till it reaches the Island of Vulcano, which probably was active during the earthquake.

Recently this kind of fault evidence was confirmed and studied again by means of satellite observation. This tectonic instability could be related to the rock formations which give off carbon dioxide fumes as noted in the recent work on the building of tunnels for the Messina-Palermo autostrada, not far from Patti.

The main shock was preceded by a small shock a few minutes before. Its record is incomplete because the seismograph at Catania University went off the scale (fig. 3) as did the one at Messina University.

As appears clear from fig. 3 the main shock was very quickly followed by an induced sussultory earthquake.

Even the seismoscope record at the Collegio Pennisi is incomplete because the pen went off the scale.

By way of comparison, the record with the same historical seismoscope (called Vicentini) of a 4.3 magnitude earthquake which occurred on 28th March 1962 at 3km from the Acireale station (Costa, 1977) is represented in fig. 5.

This station also recorded two other significant earthquakes before 15th April 1978. The first on 23rd February was of the 5th degree on the M.M. scale and the second, on 11th March 1978, was of the 3d degree of intensity on the M.M. scale.

Owing to the present lack of ENEL strong motion records at Patti, the following formulae were applied to the evaluation of the earthquake enginnering characteristics: acceleration, velocity and displacement:

$$a = 5000\ e^{0.8M}\ (R + 25)^{-2}$$

$$v_1 = 15\ e^{M}\ (R + 0.17\ e^{0.59M}) - 1.7 \quad \text{Valid if } R > 20 \text{ Km}$$

$$V_{11} = 15\ e^{M}\ (R + 0.17\ e^{0.59M}) - 2 \quad \text{Valid if } R < 20 \text{ Km}$$

$$d = \left(1 + \frac{1}{R^2}\right) \frac{v^2}{a}$$

These formulae, derived from Esteva (1969), with the same exponential structure of the attenuation law proposed by Merz and Cornell (1973), were established by Costa and Maugeri (1978) for Eastern Sicily and are valid for $M \leq 6$.

The calculation leads to the following results:

a max = 0.14g v max = 9.88 cm/sec d max = 0.71 cm

The value quoted for the displacement at Acireale was 0.08 cm which was favourable when compared to the approximately 0.30 noted by the seismic station. One can expect a better correspondence bet-

ween the calculating acceleration and the one measured at Patti by the ENEL instruments. This recorded value is still a metter of calculation by ENEL; from a first assessment it ranges around 0.16g (Capozza, 1978).

3. GEOTECHNICAL CONSIDERATIONS

The worst damaged houses in Patti were those founded on sandstone, built of masonry and rarely cemented, in the old centre of the town.

On that site the sandstone formation assumes a hill configuration, which could produce an amplification on maximum ground acceleration (Maugeri, 1976), which can explain, together with the poor construction quality, the severe destruction of some houses.

In fig. 6 the damage suffered by one wing of Patti Cathedral is visible and in fig. 7, the damage at the corner of the main nave is evident.

The new concrete buildings in Patti, shown in fig. 8, are built on fissured clay and were apparently damaged on the buffer walls only, mainly at the lower levels.

Liquefaction phenomena noted in the marshy area to the left of the town in the gulf of Olivieri could not be confirmed because their traces were quickly cancelled by human activity (fig.9). In any case limited liquefaction would be favoured by a water level near to the surface and by the regular and constant grain size of the sand of the site, and this phenomena cannot be generalised to the alluvium site.

A landslide, consisting in a rock mass failure, was observed at Capo Calavà, whose location is on the left of the Patti gulf. The slope was high and formed of very jointed and altered rock, which has been consolidated in the past by spritz beton and anchorages.

Because of the earthquakes the rock failure was accelerated and a series of blocks, from 10 to 60 cm in diameter fell down into the road. As is clear from fig. 10 the entire cliff is at present in a dangerous limit equilibrium.

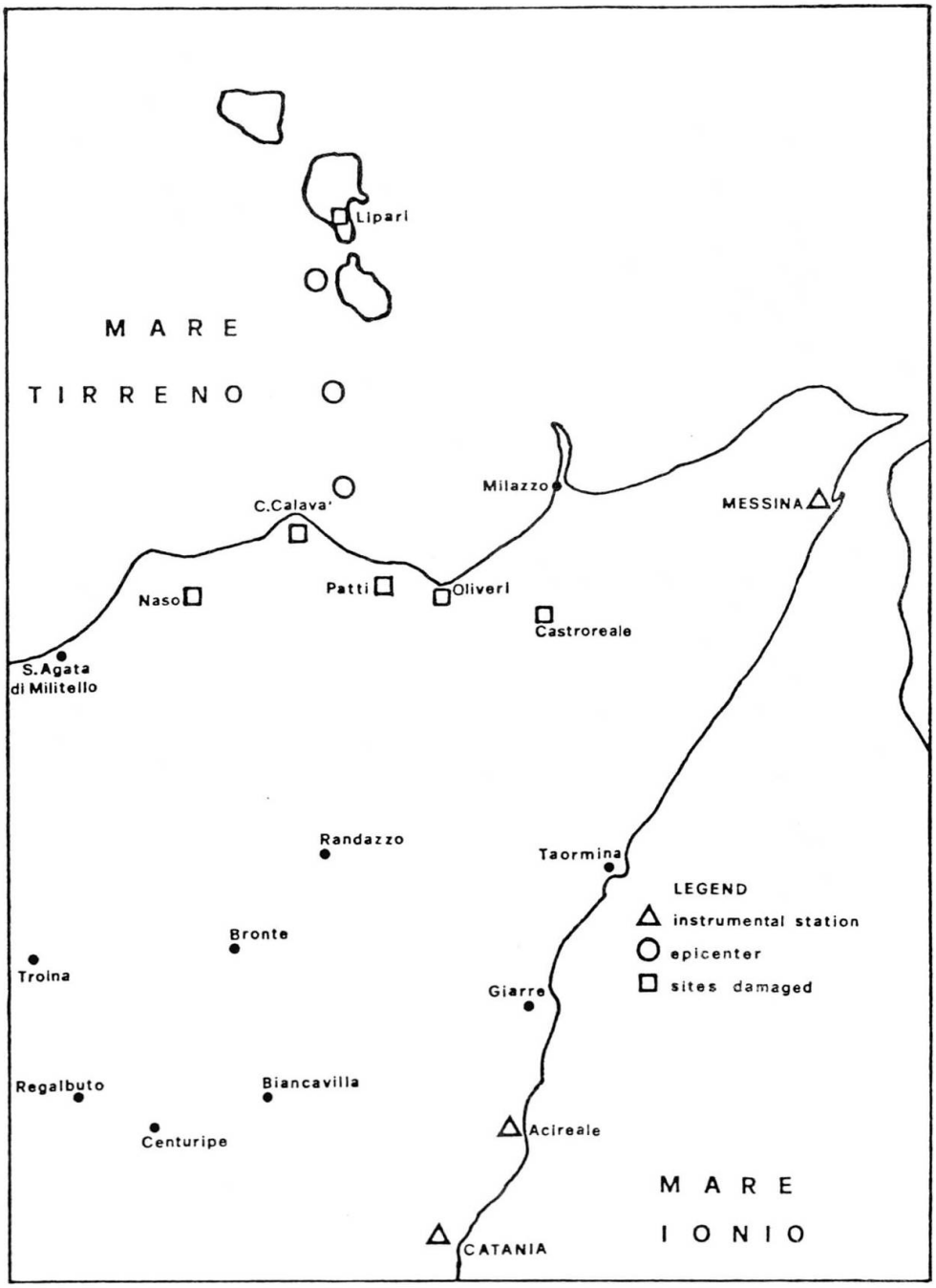

Fig. 1 : Patti Earthquake, April 15, 1978.

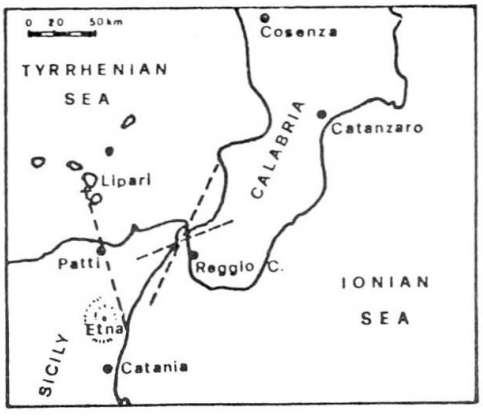

Fig. 2 : Sketch of fault probabily related to earthquake

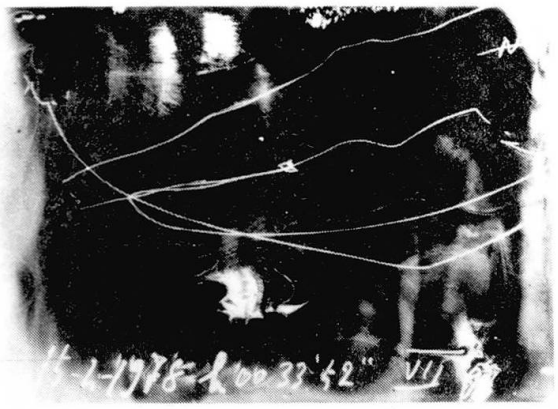

Fig. 4: Seismoscope record at Collegio Pennisi of Patti earthquake.

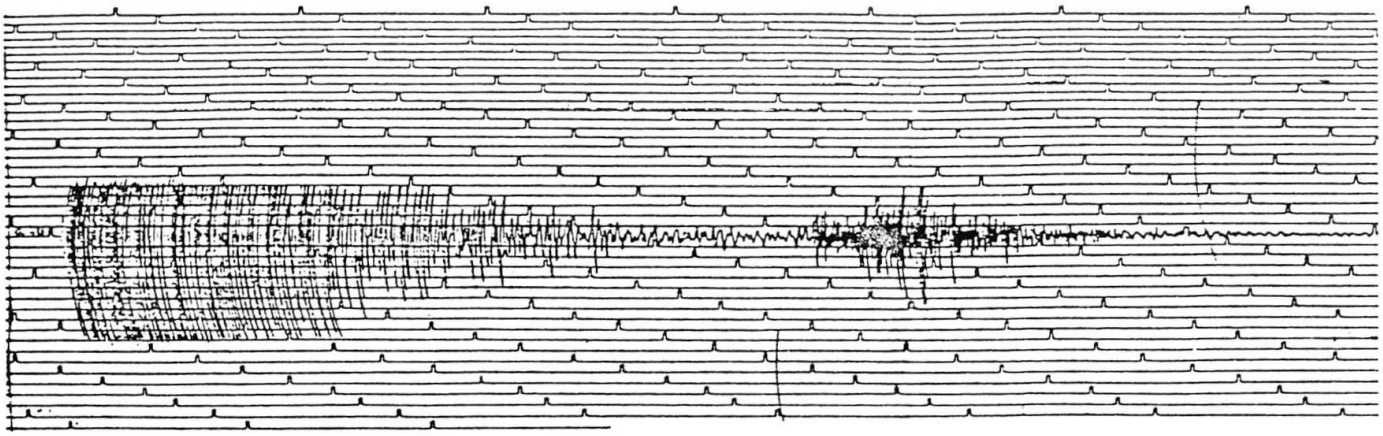

Fig. 3: The Patti earthquake recorded at the University of Catania.

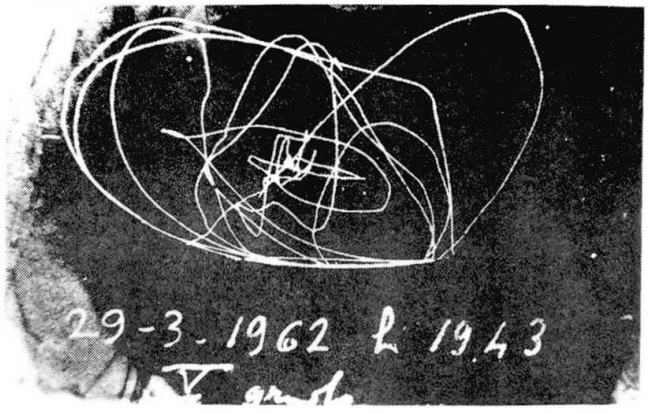

Fig. 5: Seismoscope record of a 4.3 magnitude earthquake.

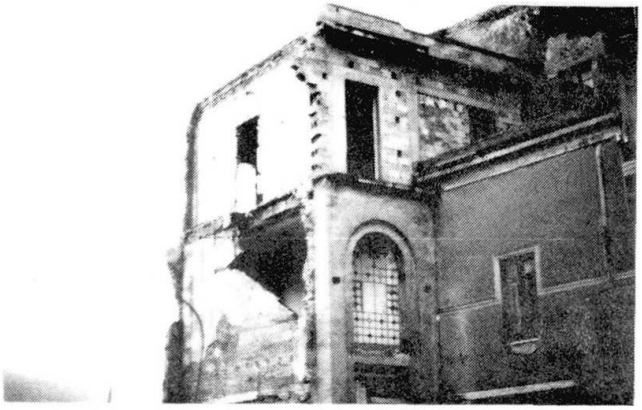

Fig. 6: Patti Cathedral: the left wing.

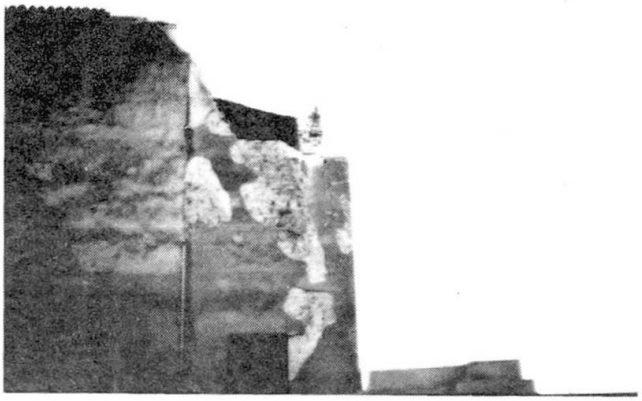

Fig. 7: Patti Cathedral: the corner of the main nave.

Fig. 8: Concrete buildings at Patti virtuolly undamaged.

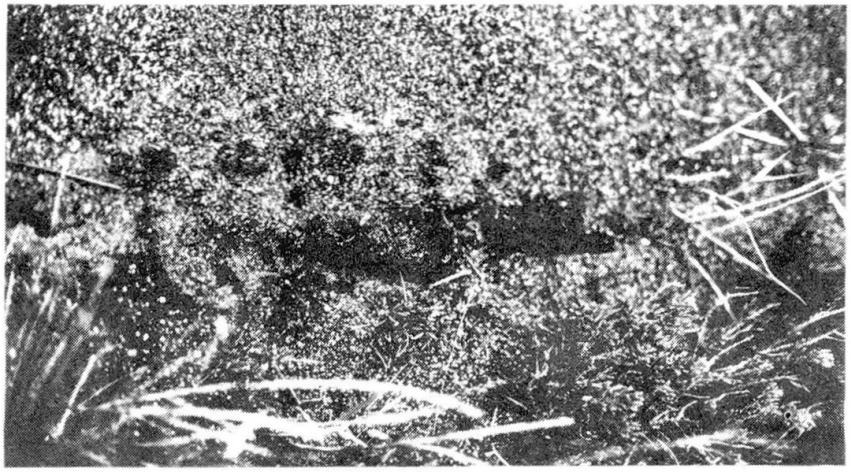

Fig. 9: Dubious traces of liquefaction.

Fig. 10: Rock fall at Capo Calavà.

REFERENCES

CAPOZZA, F. (1978): Private communication;

COSTA, C. (1977): "Le registrazioni sismiche dell'Osservatorio del Collegio Pennisi di Acireale - trasmissione attraverso terreni lavici di accelerazioni, velocità e spostamenti alle strutture". Thesis at the University of Catania; supervisor prof.M. Maugeri;

COSTA, C., MAUGERI, M. (1978): "Sismicità e curve di attenuazione per i terreni della Sicilia Orientale". Proceedings Accademia di Scienze, Lettere e Belle Arti degli Zelanti e dei Dafnici di Acireale (in press);

ESTEVA, L. (1969): "Seismic risk and seismic design decision". Seminar of Seismic Design of Nuclear Power Plants.Cambridge,Massachussetts Institute of Technology Press;

ISTITUTO GEOFISICO DELL'UNIVERSITA' di MESSINA (1978): Bollettino provvisorio 1-30 aprile. Osservazioni Sismiche anno 1978. Stazione Sismica di Messina Università.

MAUGERI, M. (1976): "Geotechnical aspects of the recent Friuli Earthquake". Proceedings of the International Meeting on the Friuli Earthquake, Udine, December 4th-5th, 1976, in Bollettino di Geofisica Teorica ed Applicata, Vol. 19, Parte I, pp. 809 - 825;

MERZ, H.A., CORNELL, C.A. (1973): "Seismic risk analysis, based on a quadratic magnitude-freauency law." Bulletin of the Seismological Society of America. Vol. 63; n. 6, pp. 1999 - 2006.

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