

Dr. Gerhard Berz,* Geophysicist
Ekkehard Hettler, Engineer

Munich, March 1981

Earthquakes in Greece, February/March 1981

Summary:

1. The two strong earthquakes that occurred during the night 24th/25th February 1981 reached the magnitudes of 6.6 and 6.3 respectively on the Richter Scale. The epicentre was in the region of the Alcionides Isles in the eastern part of the Gulf of Corinth, some 20 km north of Corinth and 70 km west of Athens. The aftershocks, which were unusually heavy, lasted approx. 2 weeks.
2. Damage, which has meanwhile been estimated at around US \$ 840 million, is concentrated on the tourist city of Loutraki and on a few smaller communities on the Gulf of Corinth (intensity VIII - IX on the Modified Mercalli Scale). In contrast, the damage in Corinth and Athens (intensity VI - VII on the Modified Mercalli Scale) was slight. With few exceptions, no serious damage was caused in the industrial areas between Athens and Corinth. Subsoil conditions influenced the extent of the damage to a high degree. Building codes and supervision thereof must be made more stringent.
3. The insurance industry was confronted with hardly any claims whatever, since earthquake covers have to date been sold in isolated cases only. The earthquakes themselves did not result in a considerable demand for appropriate covers.

*EERI 1977.

During the night 24th/25th February 1981, the south of Greece was struck by two severe earthquakes. The focal area was situated in the region of the Alcionides Isles in the eastern part of the Gulf of Corinth some 20 km north of Corinth and 70 km west of Athens. The main quake occurred at 10.53 p.m. local time and reached a magnitude of 6.6 on the Richter Scale. At 4.35 a.m., there was a serious aftershock with a magnitude of 6.3. Seismic activity in the next two weeks was extraordinarily severe: one quake of magnitude 6.2 (on 4th March 1981) was recorded plus a series of quakes of between magnitudes 5 and 6. At several points in the Perachora/Loutraki area and north-east of the Alcionides, surface breaks over a total length of about 30 km were observed that have a direct connection with the seismic activity.

An area of several hundred km in diameter was affected by the quakes, and damage was caused in a circle of about 100 km diameter around the epicentre, this being more or less the area that experienced intensities of VI and above on the Modified Mercalli Scale. However, particularly severe damage was caused solely in a radius of 20 - 30 km around the epicentre. Here, the intensity reached VIII - IX, this being reflected in the collapse of numerous simple dwellings but also of modern hotels and factories. Horizontal forces are alleged to have reached 37% of gravity, i.e., of the weight of the buildings.

The number of collapsed and seriously damaged structures was said to be 8,500, the figures for slightly damaged buildings was given as 10,000. Official sources have estimated the total damage at US \$ 640 million. Home owners are to receive up to US \$ 20,000 from Government funds in the form of loans at low interest and with long terms so that they can carry out the necessary repairs or reconstruction work quickly. The number of homeless was at times estimated to be 100,000, this being, however, attributable to the fact that panic broke out among the population. Official sources reported that 22 people were killed during this series of quakes. It can be assumed that the number of dead would have been hundreds, perhaps even thousands, if the quake had occurred in the peak tourist season.

Damage was restricted to the tourist centre of Loutraki and to some smaller communities in the region between Corinth and Thebes. Here

a large number of buildings of natural stone but also modern reinforced-concrete structures collapsed or were severely damaged. Most spectacular was the total collapse of five hotels with a total of 1,300 beds. As in many comparable cases, the main cause of collapse was inadequate stiffening of the ground floors, which primarily serve as reception areas and restaurants and thus have only a small number of loadbearing walls. An additional factor is that the majority of hotels in Loutraki was built around ten years ago during a time of rapid development of the tourist industry and was obviously constructed without attention being paid to the necessary quality in design and execution. In this context, the significance of construction supervision should be stressed: If such supervision is stringent enough, mistakes during the design phase can be made good, for even the best design is of no use if construction work is done lackadaisically. Speaking in general terms, it was faulty design that caused most of the earthquake damage, the damage in most cases being aggravated by faulty construction material and low-quality building work.

The intensity of the seismic forces was influenced to a high degree by the subsoil conditions. All hotels that collapsed were built on alluvial soil and were not far away from the beaches. The presumed reason for the rise in intensity was a shifting of the energy of the seismic vibrations into the long-period range; this phenomenon has often been observed in soft alluvial soil and reclaimed land. The result is that more energy is transmitted to buildings that vibrate in the same frequency range.

No liquefaction was observed, but there was settlement in reclaimed land, and the quake also caused landslides. The latter led to fairly severe damage to buildings, particularly in Perachora, which is situated in mountainous terrain.

The extensive industrial areas west of Athens were obviously not affected to any great degree. This was proved during an inspection of the "Aspropyrgos" oil refinery in Elefesis, where the sole evidence of damage were a few slight cracks in the walls of the administrative building. In contrast, the impact on industrial plant in the Isthmus region (between Theodori and Corinth) was

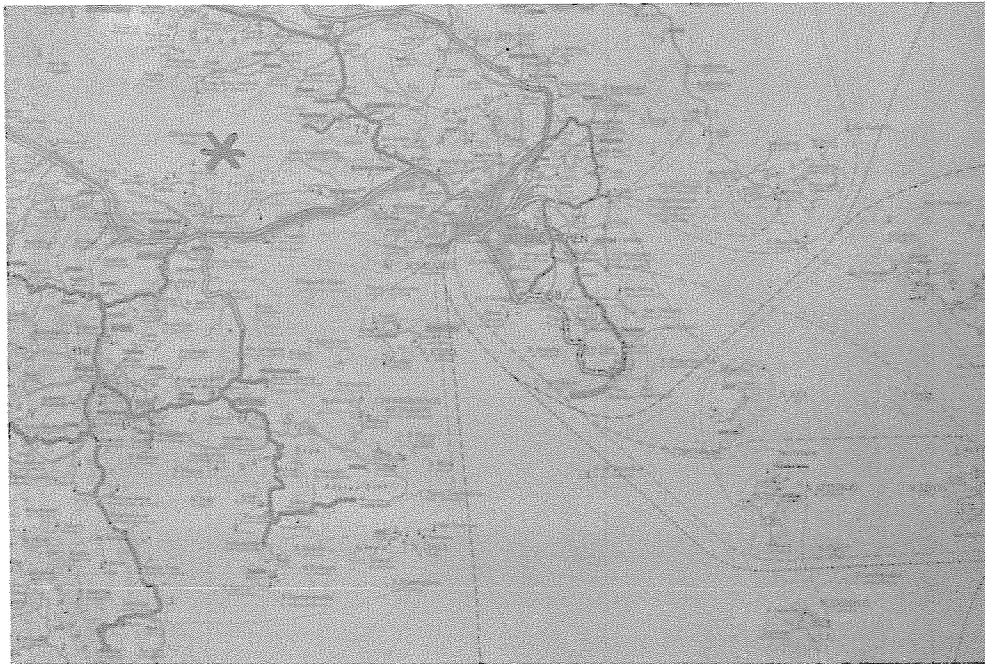
substantially greater: The multi-storey production shed of a factory that manufactures ceramics for sanitary purposes collapsed; the open-air store was also heavily hit. One plant belonging to Landis & Gyr, a Swiss enterprise that manufactures counting, metering, regulation and control equipment, suffered much damage, especially in the non-loadbearing masonry and in a double-wall facade built for insulation purposes, whereas a newly built reinforced-concrete shed with walls filled with concrete hollow tiles, bonded wooden beams and an insulated plate roof survived the quake more or less unscathed.

In Athens, the main quake and aftershocks were so extreme that panic broke out among the population in each case. Damage was limited to cracks, particularly in non-loadbearing construction components and to especially fragile building contents. The same applies to Corinth, although here the intensity was definitely higher (some VII Modified Mercalli as compared with VI in Athens). It is probably the case that the strict antiseismic codes introduced in Corinth after the serious quake on 22nd April 1928 went to preventing damage.

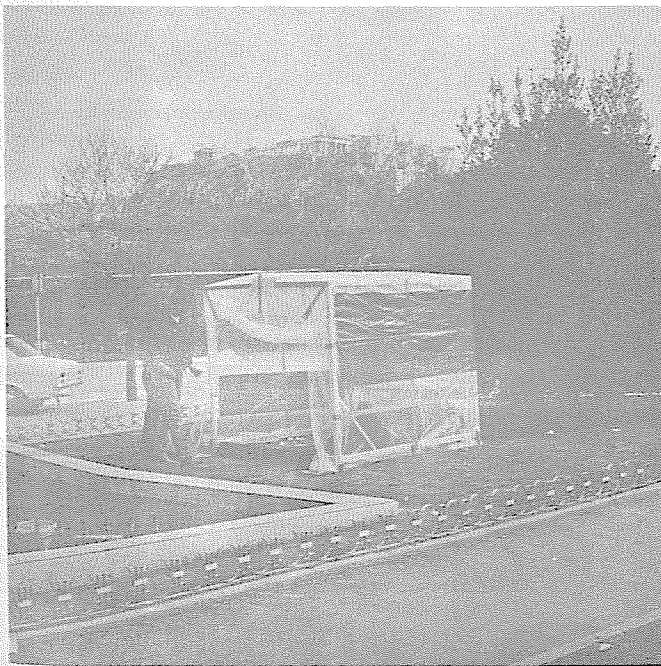
The insurance industry was spared losses to all intents and purposes, since Fire policies in Greece do not include the earthquake hazard. The appropriate additional cover against earthquake shock is fairly expensive according to the tariff and for this reason not very popular.

In the Athens/Corinth area, allegedly a mere few hundred earthquake policies are in force at the moment. There was no noticeable increase in demand after the earthquake. In the Engineering sector, earthquake is automatically covered under CAR/EAR and EEI policies.

The inspection of the area affected and of several industrial risks during the period 5th - 7th March 1981 was prepared by the "Ethniki", "Astir" and "Phoenix" insurance companies, some of their staff members having accompanied us. Furthermore, there was a visit to the Seismological Observatory in Athens and discussions with scientists from the Technical University in Athens.



1: The epicentre is some 70 km west of Athens.



2: Fearing aftershocks, numerous inhabitants of Athens preferred to live in makeshift dwellings.

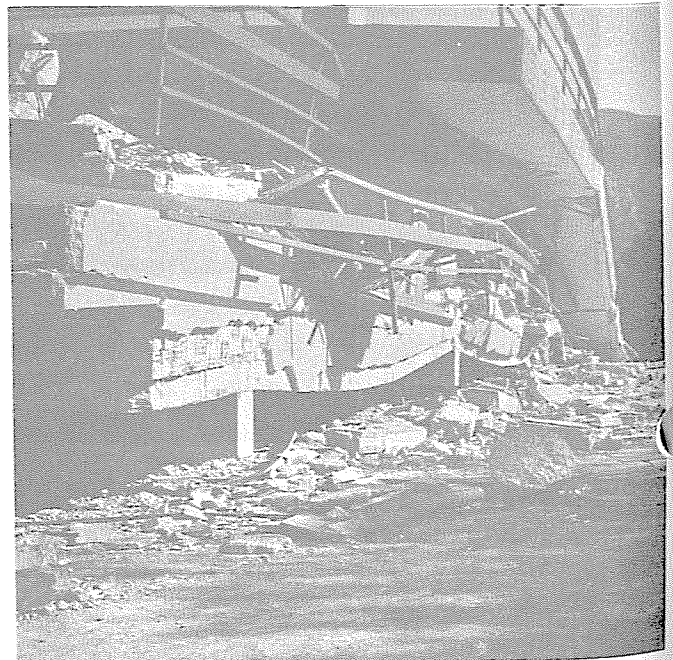
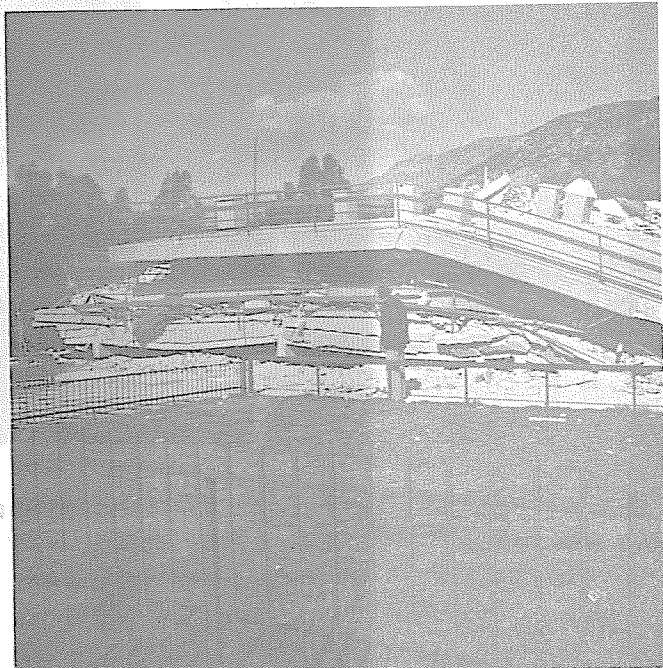
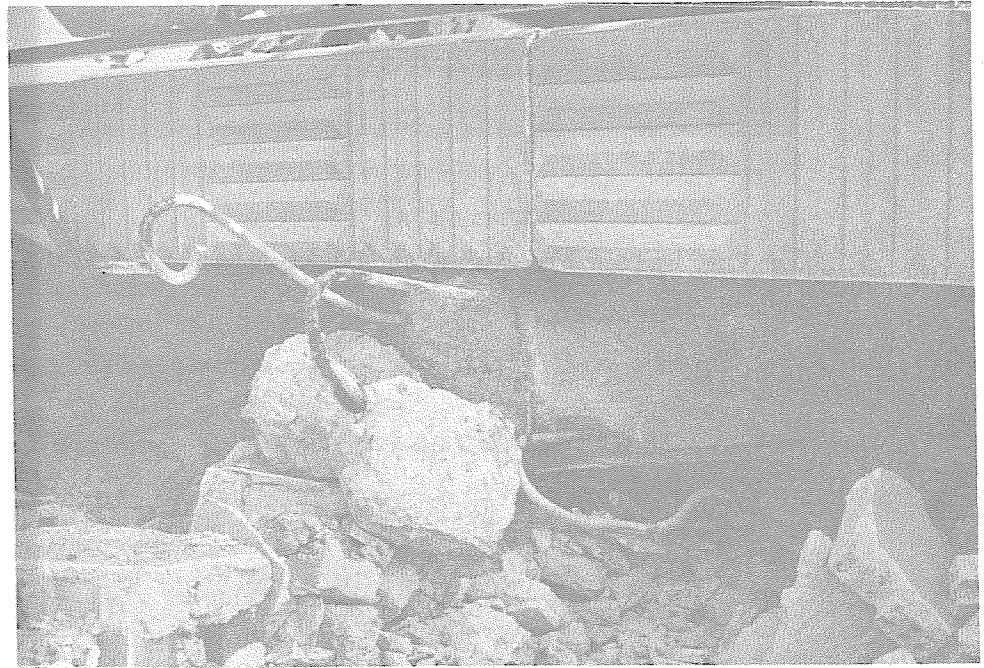
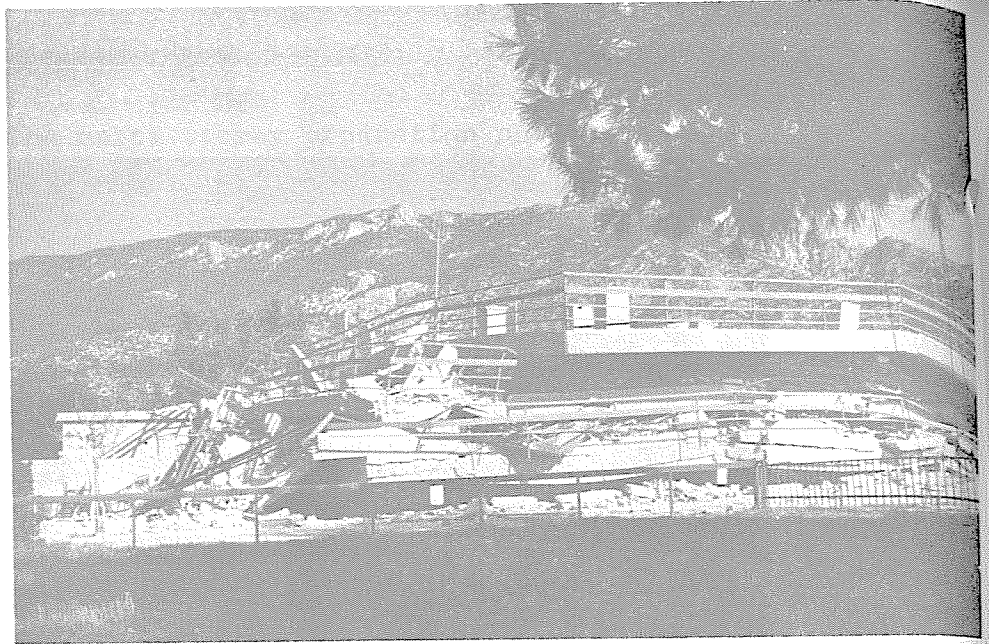


3: Earthquake damage in Athens was only slight.

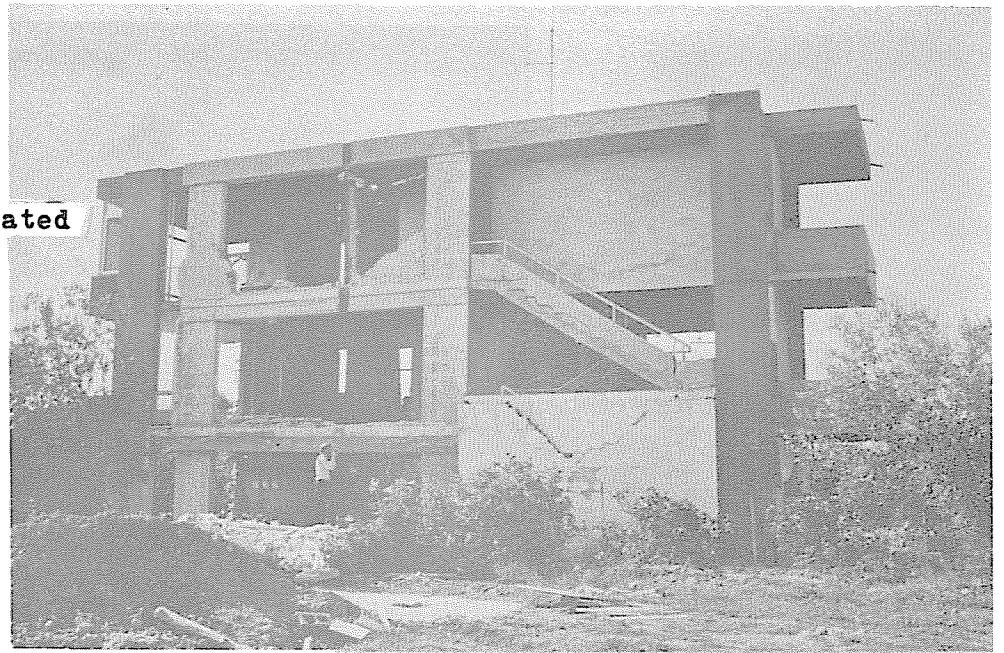
4 - 7:

This picture shows a collapsed hotel approximately 40 km west of Athens. The two upper storeys had been built onto the ground floor after its completion.

In view of the weight of the ceiling, the number of columns was too small. The soft sediment subsoil probably strengthened the seismic movements.



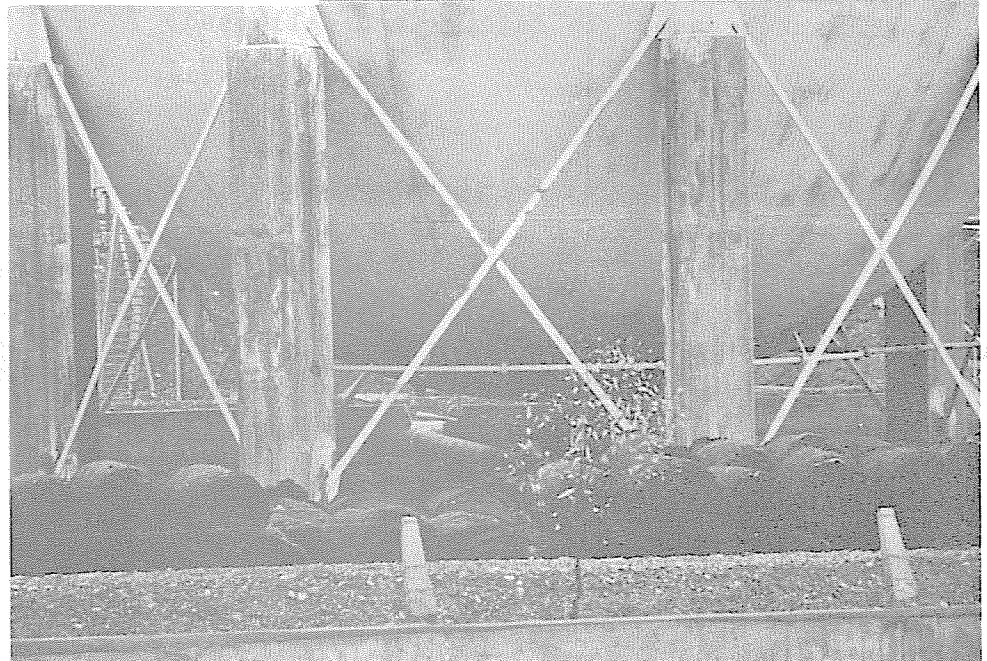
8: This reinforced-concrete frame construction oscillated strongly, causing serious damage to the non-load-bearing walls and to the stairs.

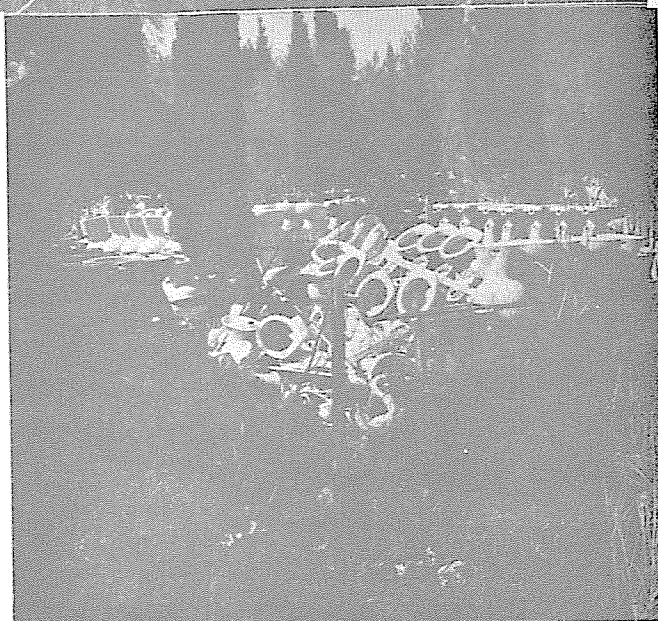
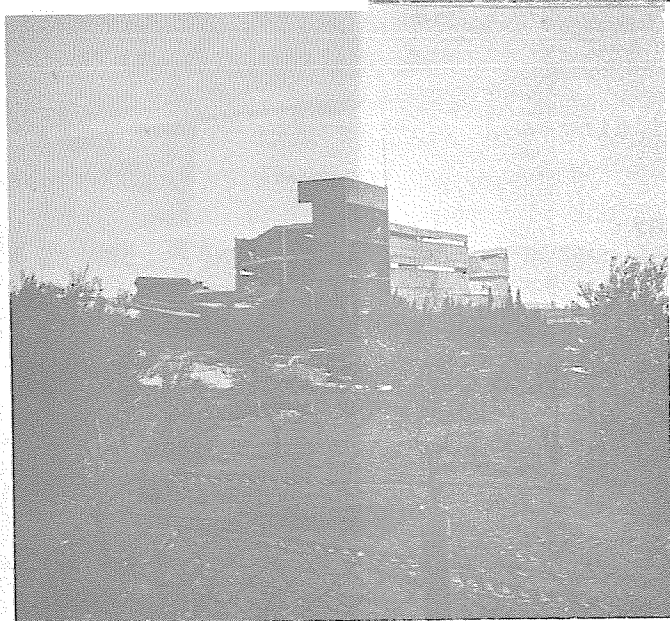


9: This brick building without frame construction cracked in many places.



10: In the "Motor Oil Hellas" refinery near St. Theodori, the foundations and supporting columns of two spherical LPG tanks were damaged.

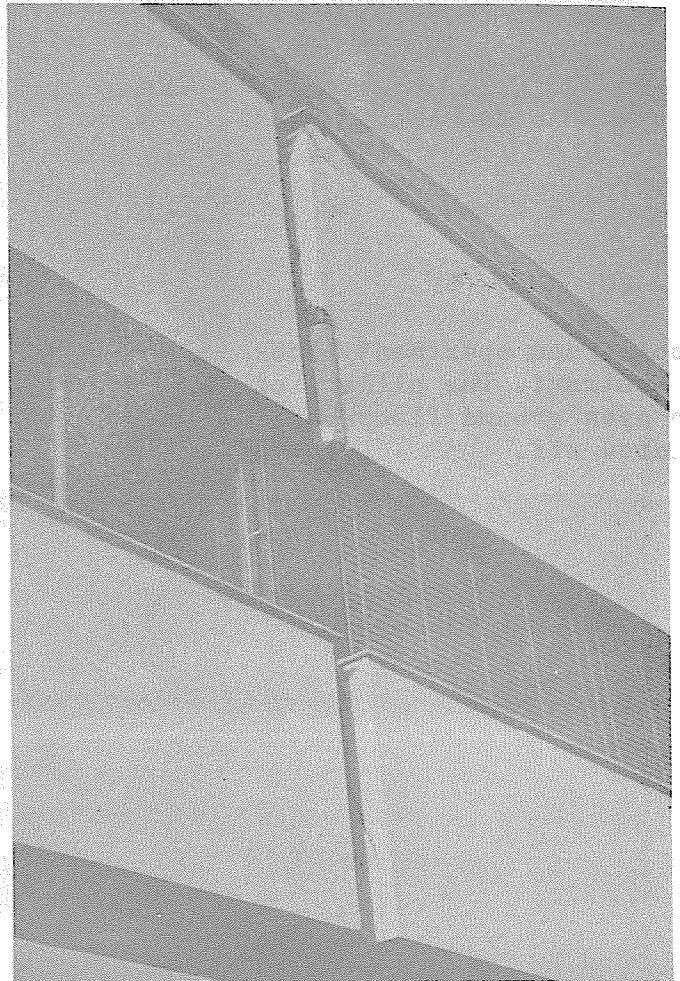
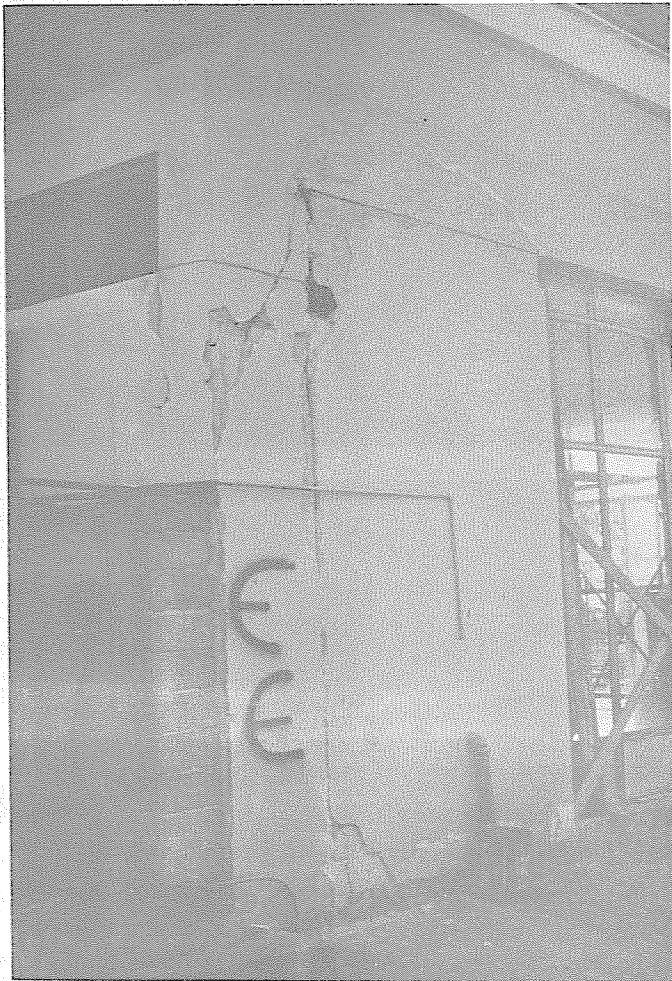




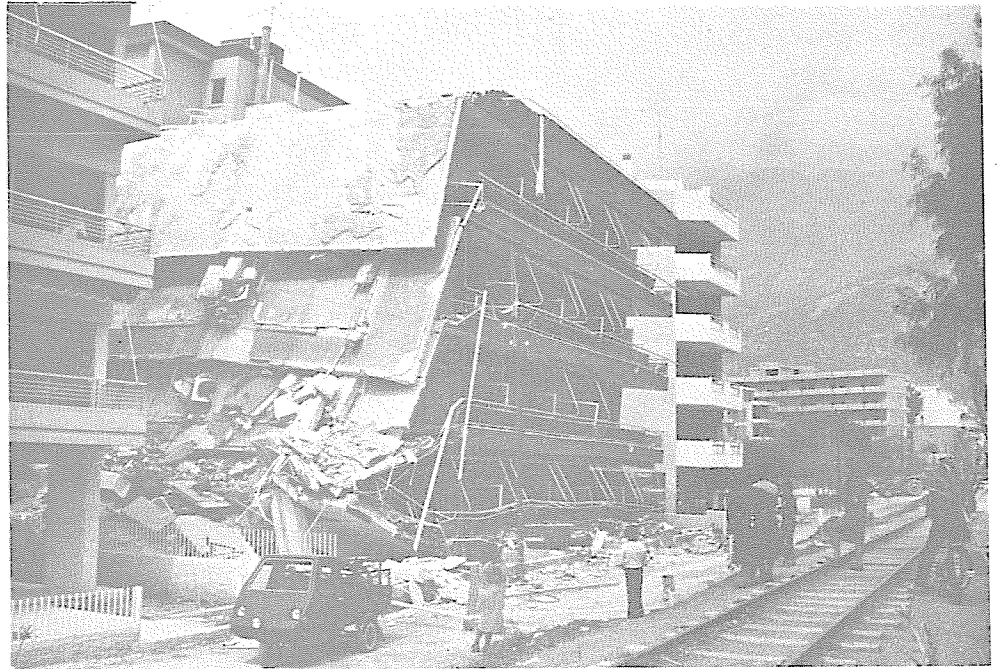
11 - 13: Large parts of the production shed and the open-air store of a ceramics factory near the Isthmus had collapsed.

14: This building with holiday flats on the Bay of Loutraki was severely damaged but could still be lived in.





15 - 17: The reinforced-concrete frame, its brick filling, and the brick façade of this building belonging to Landis & Gyr, manufacturers of counting, metering, control or regulation equipment, were severely damaged.



18 - 20:

A collapsed apartment block in Loutraki. The pillars of the open ground floor had snapped off.

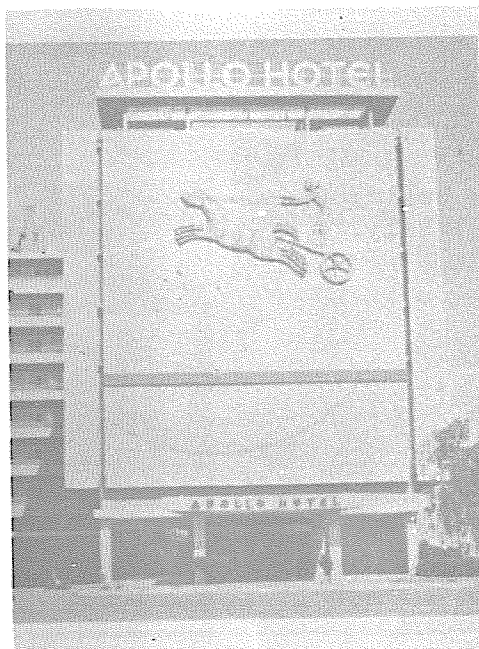
21: One section of the building
had collapsed completely.



22 . 23:

The collapsed hotel 'Contis'
in Loutraki.





HOTEL APOLLO

This spacious, comfortable hotel is about a mile from the centre of Loutraki, where you'll find a selection of lively bars, tavernas and discos, and a wide choice of small shops. The Apollo is situated directly by the wide shingle beach.

- *swimming pool
- *garden terrace
- *beach bar in high season
- *hotel bar and lounge
- *full air-conditioning
- *dining room with views towards sea
- *à la carte menu available
- *crockets available
- *cards and TV
- *games room

- *piano music in lounge most evenings
- *discos open most nights
- *live band in high season
- *Greek dancing usually once a week
- *hairdressers
- *children's early supper, cot and highchairs available
- *children's playground

Hotel bedrooms: 271
Lifts: 3



24 - 26:

The 8-storey "Apollo" hotel in Loutraki was razed to the ground.



27 - 29:

All that was left of the "Apollo" hotel.



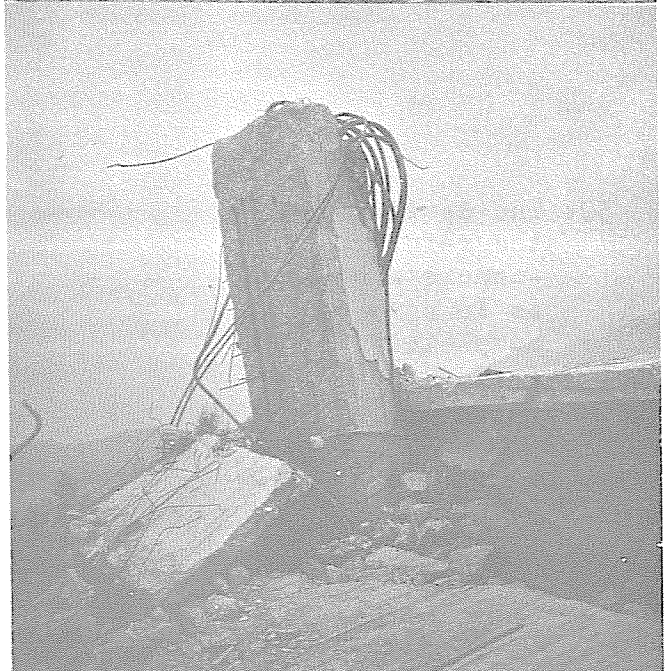
30: The design of the reinforced-concrete pillars is in some cases completely inadequate.





31 - 33:

Some massive reinforced-concrete pillars only stretch into the second storey. The reinforcement is not tied properly.



34
Hal
Con
ju
co
re
in
of



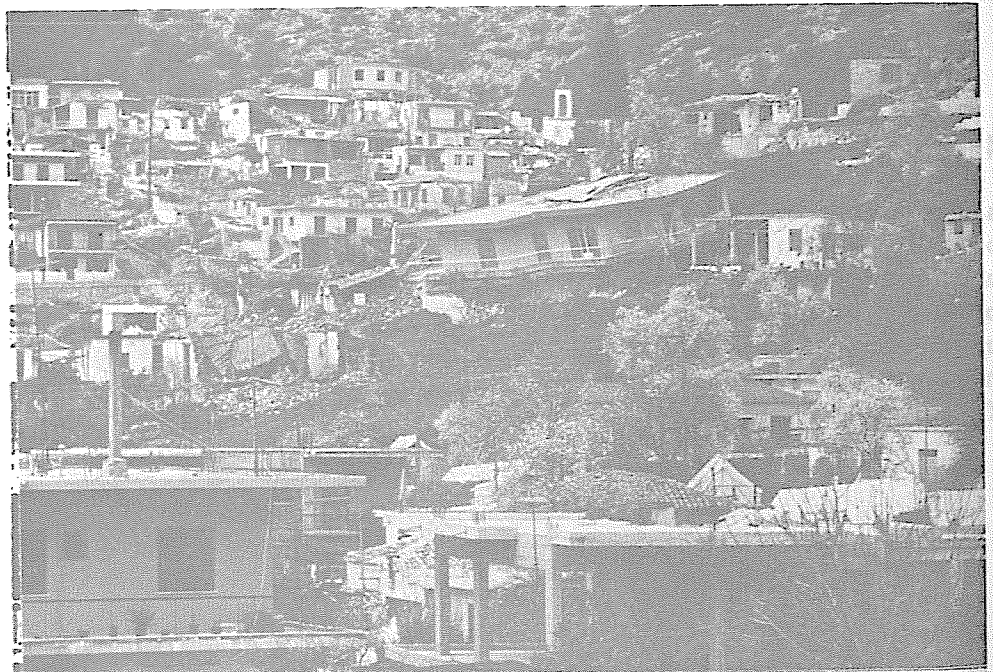
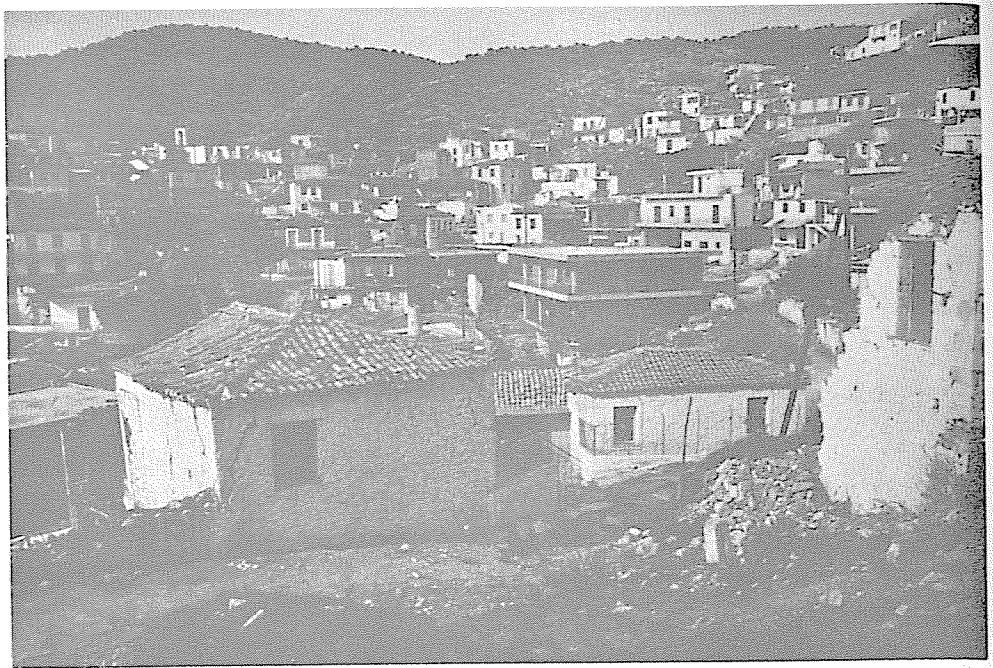
34 - 36:

Half of this hotel west of Corinth, which had only just been completed, collapsed. Shops and restaurants were situated in the first two storeys of this section.



37 - 39:

Perachora, north of I utraki. This community was the one nearest to the epicentre. Numerous buildings collapsed or sustained serious damage.



40: Again Perachora.
This church of quarry
stone collapsed.

