

PRESIDENT
HENRY J. DEGENKOLB

VICE PRESIDENT
ANESTIS S. VELETSOS

SECRETARY
FRANK E. MCCLURE

TREASURER
R. GORDON DEAN

NEWSLETTER EDITOR
DAVID J. LEEDS

EARTHQUAKE ENGINEERING RESEARCH INSTITUTE

(A NON-PROFIT CORPORATION)

424 - 40TH STREET
OAKLAND, CA. 94609
TELEPHONE (415) 655-6699

DIRECTORS

MIHRAN S. AGBABIAN
WALTER A. BRUGGER
HENRY J. DEGENKOLB
HARESH C. SHAH
ROLAND L. SHARPE
ANESTIS S. VELETSOS
WILLIAM T. WHEELER

SPECIAL PROJECTS
DONALD F. MORAN

ENGINEERING ASPECTS OF THE LIMA, PERU EARTHQUAKE OF OCTOBER 3, 1974

BY

THE EERI RECONNAISSANCE TEAM

Donald F. Moran, Team Leader

Greer Ferver

Charles Thiel, Jr.

James Stratta

Julio Valera

Loring Wyllie, Jr.

PRELIMINARY RECONNAISSANCE REPORT
JANUARY, 1975

FOREWORD

Immediately following the October 3, 1974 Peru earthquake, the General Earthquake Response Plan, developed and adopted by the Earthquake Engineering Research Institute (EERI), was activated and preliminary information on the earthquake and its effects were gathered from news releases and the U. S. Geological Survey (USGS). Based on this information, it was decided to send a reconnaissance team (RT) to the area. The RT arrived in Lima on Monday morning, October 6, 1974 and left the following Saturday. Information, telephoned from Lima by the RT, indicated that the damage did not justify additional research teams.

This investigation provided the first use of materials developed in the EERI/NSF Earthquake Investigation Project. Valuable experiences were gained from their use.

This Preliminary Reconnaissance Report is interim as a more complete and detailed Reconnaissance Report is being prepared by members of the RT for later publication. The purpose of this interim report is to furnish information to the EERI membership prior to their annual meeting on February 8, 1975.

The RT's efforts were aided significantly by the willing and valuable assistance of many Peruvians. We are particularly grateful to the Lima engineering firm of Gallegos, Rios, Casabonne, Ucelli, and Icochea for their assistance. Sr. Alberto A. Giesecke M., Director of the Central Seismological Region of South America provided important information. The USGS National Earthquake Information Service furnished the seismological data and Charles Knudson of the USGS Seismic Engineering Branch provided the strong motion accelerograph data and discussion. The National Science Foundation authorized the expenditure of current EERI Grant funds to reimburse some of the team members for travel expenses. The members of the RT and their employers have donated time and expenses.

Henry J. Degenkolb
President

CONTENTS

	Page
FOREWORD	i
INTRODUCTION	1
Background	1
Seismicity	1
Geology	4
Surface Soils	6
GEOSCIENCE DATA	6
Seismology	6
Strong Motion Accelerograph Records	6
Tsunami and Geodetic Movements	7
ENGINEERING EFFECTS	9
Intensity Distribution	9
Soils	11
Buildings	11
Lifeline Systems	15
PRELIMINARY CONCLUSIONS	16
REFERENCES	18
FIGURES:	
1. Central Coastal Region of Peru	2
2. Metropolitan Lima	3
3. Geology of the Department of Lima - Coastal Sector	5
4. Strong Motion Accelerograph Records - Oct. 3, 1974	8

INTRODUCTION

At 9:21 a.m., Thursday, October 3, 1974 a strong earthquake caused a total of 70 deaths in Lima, Peru and in several small villages to the south. The Geophysical Institute of Peru reports property damage to be 200 million dollars.

This preliminary report summarizes the gathered data, observations, and conclusions of the EERI Reconnaissance Team (RT). The conclusions are limited to the engineering aspects since this reflects the expertise of the members of the RT. All of the data and conclusions presented in this report must be considered preliminary since research is currently being conducted by the USGS, the Geophysical Institute of Peru, the members of the RT, and others.

Some building regulations exist in Peru, however, anti-seismic design provisions for specific buildings are largely left to the discretion of the responsible engineer.

The objectives of this report are to present and discuss the lessons learned from this earthquake in order to mitigate the effects of future shocks. The statements made and conclusions reached herein are not intended to be hypercritical of any particular design, material, or construction method.

Background

Lima is located on a narrow coastal plain adjacent to the western foothills of the Andes (Fig. 1). The climate is arid with practically no rainfall and the geography is desert

Metropolitan Lima has a population of about 3 million, many modern high-rise buildings, a few freeways, and sophisticated community lifeline systems (Fig. 2).

Seismicity

The Peruvian region is a segment of the Circumpacific Belt. The highest seismicity is found in the coastal areas north and south of Lima. Table 1 lists some major seismic events which have affected Lima.

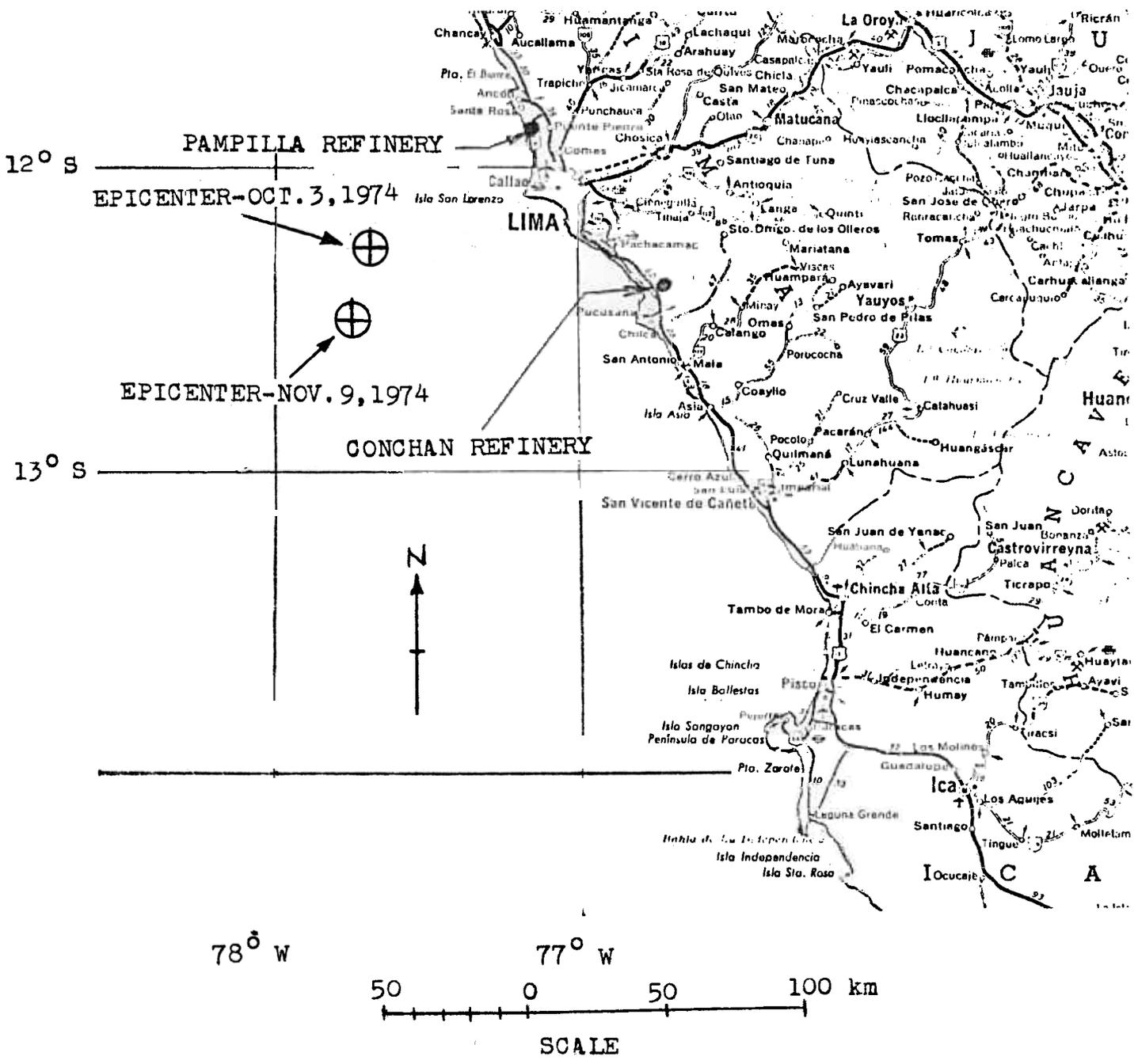


Figure 1
Central Coastal Region of Peru



Figure 2
Metropolitan Lima

TABLE 1
MAJOR SEISMIC EVENTS AFFECTING LIMA, PERU

<u>Date</u>	<u>Magnitude</u>	<u>M.M. Intensity In Lima</u>	<u>Remarks</u>
1586, July 9			
1655, Nov. 13			
1687, Oct. 20			
1746, Oct. 28			
1828, Mar. 30			
1940, May 24	.8.4	?	Near Huacho (Fig. 3)
1966, Oct. 17	.7.5 .	VII	Near Huacho
1970, May 31 .	.7.7	?	. Centered offshore of Chimbote, about 230 Km. north of Lima
1974, Jan. 4 .	.6.2 .	?	. Centered inland
1974, Oct. 3 .	.7.6 .	VI-VIII	
1974, Nov. 9	.7.2 .	?	. Aftershock of Oct. 3, 1974 Earthquake

It should be noted that there have been at least 4 potentially damaging shocks affecting Lima in the last 8 years, therefore, the probability of cumulative and unrepaired damage in the weaker buildings must be recognized in any evaluation of current damage. Structures which have been forced into the plastic range or that have partially failed lose a portion of their ability to successfully withstand future loadings unless they are adequately repaired and/or strengthened.

Geology

Figure 3 presents a geologic sketch of the coastal sector near Lima (from Reference 1).

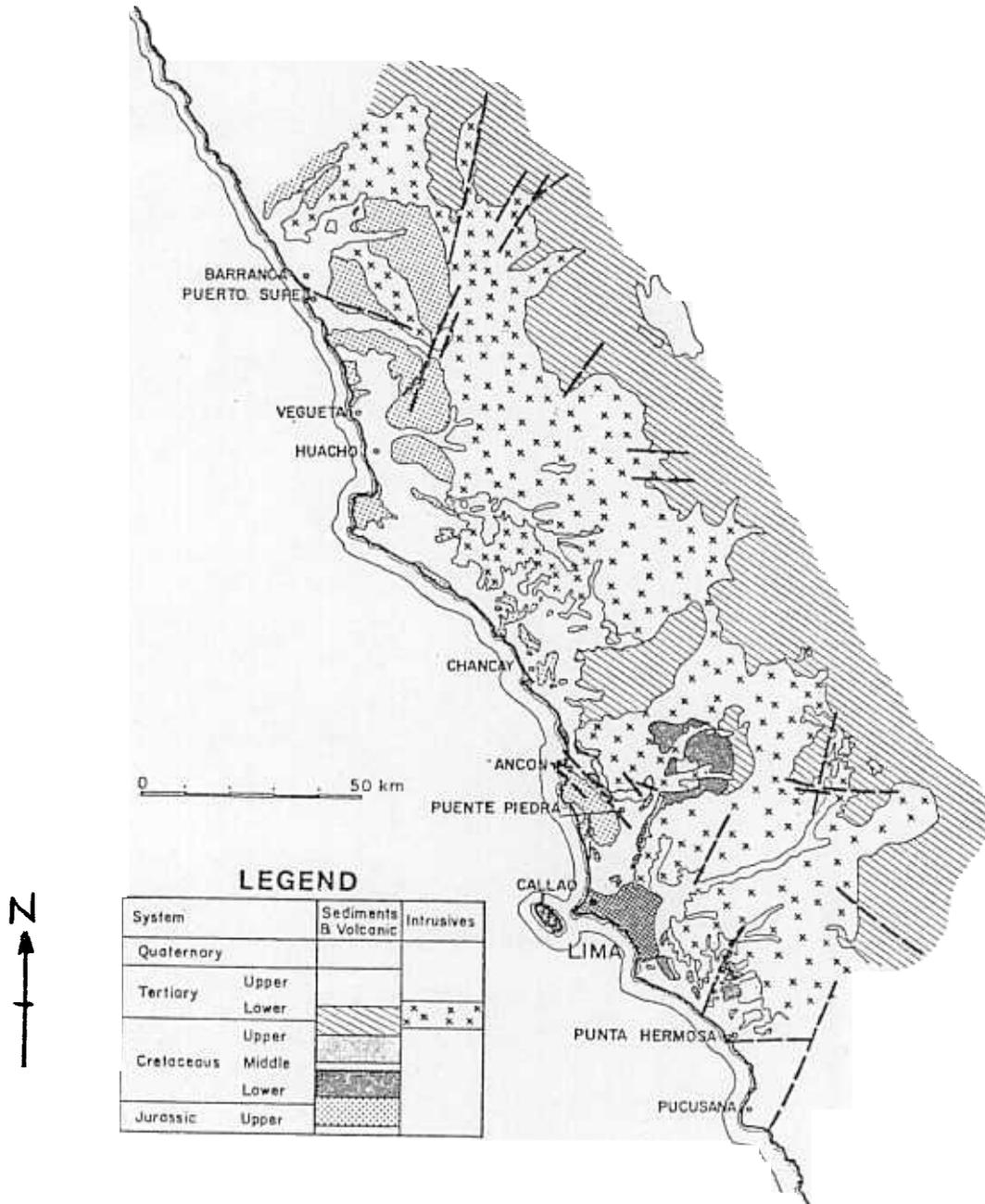


Figure 3
 Geology of the Department of Lima - Coastal Sector

Surface Soils

There are very few data available on the subsurface soil conditions in the city of Lima and the surrounding area. Most of the available data come from the few foundation investigations which have been performed for various structures throughout the city.

In general, the subsurface soils underlying Lima consist of a conglomerate made up of boulders, cobbles, and gravel in a matrix of silty sand (hardpan). This material is very hard and compact. Bedrock is encountered at depths ranging from 100 to 200 meters. The soils are very competent from a static load bearing capacity point of view and cuts up to 60 feet high are able to stand almost vertically without any signs of distress. All of the major high-rise structures in central Lima are founded on spread footings or mat foundations with allowable soil pressures ranging from four to five kg/cm² (8,000 to 10,000 pounds per square foot).

The annual rainfall within the city of Lima and the outlying area is on the order of $\frac{1}{2}$ cm (0.1 inch). This may account for the water table being located at a depth of about 60 meters, except near the ocean (Callao and La Punta) where the level is at a depth of 5 to 10 meters. At the Agricultural University in La Molina the water table is about 13 meters below the surface.

GEOSCIENCE DATA

Seismology

The main shock occurred at 9:21:31 a.m. Lima, Peru local time. The Richter Magnitude was about 7.6 according to the USGS National Earthquake Information Service. However, the Geophysical Institute of Peru reports a magnitude of about 6. This large discrepancy has not been resolved at this time. The epicenter was located offshore about 70 Km (43 mi.) west-southwest of Lima (Fig. 1). This location is well east of the deep offshore trench which roughly parallels the coast. The focal depth was about 35 Km. in an ocean depth of some 500 meters. Duration was about 2 min. and 15 sec.

An aftershock occurred on November 9, 1974. Magnitude was about 7.2 and the epicenter was located slightly southwest of the October 3, 1974 main shock (Fig. 1). Focal depth is estimated at 34 Km.

Strong Motion Accelerograph Records

Two accelerographs recorded the earthquake of Oct. 3, 1974. One was located at the Geophysical Institute of Peru in

central Lima and the other (a SMA-1) at the Dr. Huaco residence in Lima's eastern suburbs (Fig. 2). The Geophysical Institute of Peru sent these records to the Seismic Engineering Branch of the USGS for processing and analyses. A reproduction of the major portion of both of these records is shown in Figure 4. Preliminary scalings of these records give the values shown in Table 3.

TABLE 3
PRELIMINARY ACCELEROGRAPH DATA - OCT. 3, 1974

<u>Instrument</u> <u>Location</u>	<u>Maximum Peak Recorded Accel.(g)</u>			<u>Length of</u> <u>Record</u> <u>(Sec.)</u>
	<u>Vertical</u>	<u>Long.</u>	<u>Transv.</u>	
Geophysical Inst.	13	.24	.21	138
Dr. Huaco Res. (SMA-1)	.12	.17	18	116

The peak readings for the Geophysical Institute record occur approximately 20 seconds following the triggering of the instrument and the higher amplitude portion of the Dr. Huaco residence record begins about 15 seconds after triggering and continues for about 65 seconds thereafter.

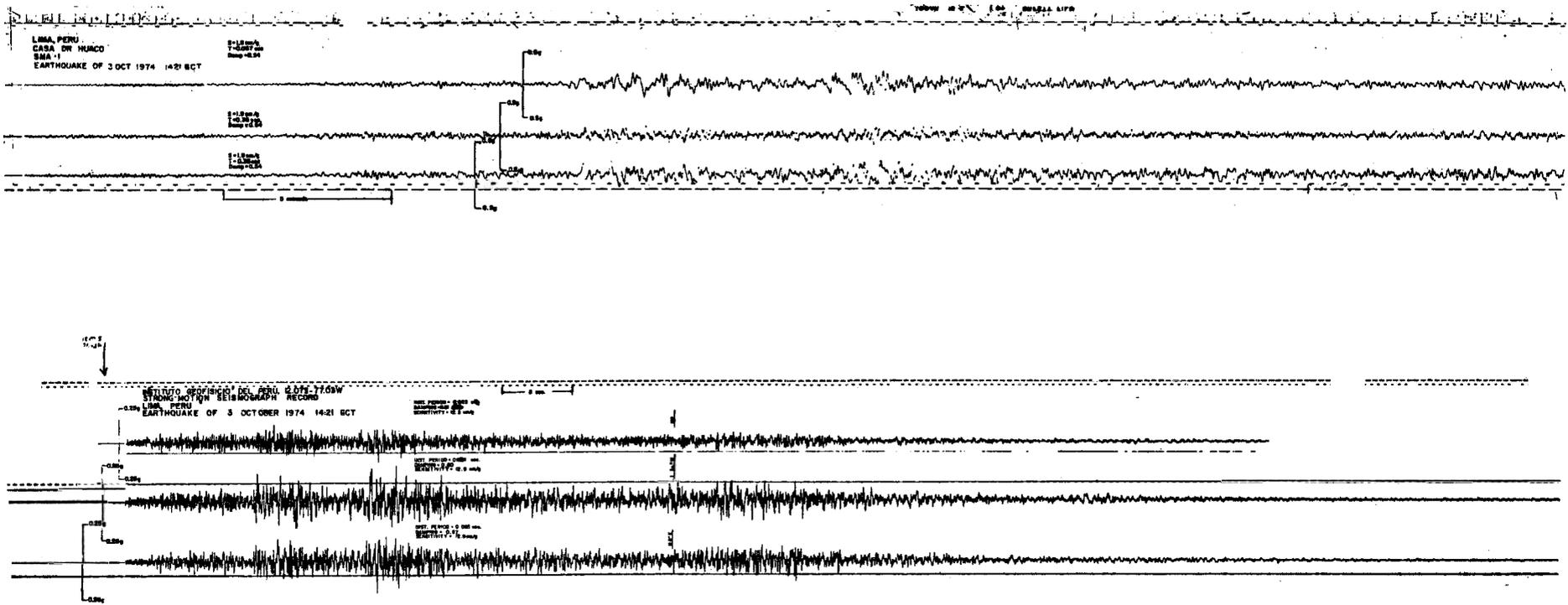
The accelerograph located at the Geophysical Institute was the only strong-motion instrument in Peru from 1944 until early 1974. The October, 1966 and the May, 1970 Peruvian Earthquakes as well as several other destructive earthquakes have been recorded on this instrument. The SMA-1 instrument was formerly located at the Zarate station and there recorded the destructive earthquake of Jan. 5, 1974. The SMA-1 was moved from the Dr. Huaco residence to the Agricultural University in La Molina prior to the aftershock of Nov. 9, 1974. Aftershock records were obtained from this instrument as well as from the one at the Geophysical Institute. These records are being processed by the USGS Seismic Engineering Branch.

Tsunami and Geodetic Movements

The RT observed what appeared to be tsunami effects in the coastal resort area of Ancon (Fig. 1). A small amount of water reportedly came over a battered stair type ocean wall and a light standard was moved. However, according to the Geophysical Institute of Peru the tsunami has not been verified on tidal gauges nor were there any evidences of geodetic movement. No surface faulting has been reported.

Strong Motion Accelerograph Records-Oct. 3, 1974

Figure 4



ENGINEERING EFFECTS

Intensity Distribution

The following estimates of Modified Mercalli Intensities (MMI) are based on field observations of the RT from Ancon to Pisco (total of 250 Km) and a maximum of about 15 Km inland in the vicinity of the La Molina area of Lima (Figs. 1 and 2).

TABLE 2

ESTIMATED INTENSITIES - MODIFIED MERCALLI SCALE

<u>Location</u>	<u>Intensity</u>	<u>Remarks</u>
Ancon	V	Fig. 1
Lima		Fig. 2
Central Area	VI	Vicinity of Sheraton Hotel
Chorillos	VII	
Barranco	VII	
La Molina	VIII	
La Punta	VII	At Naval Academy
Chilca	VII	Fig. 1
Cerro Azul	VII	Fig. 1
San Vicente de Cañete	VI - VII	Fig. 1
Pisco	V - VI	Fig. 1

The reasons for the abrupt increase of intensity in the La Molina area are not completely understood. They may be related to the local topography of the area and to the subsurface soil conditions. La Molina is situated in a bowl-shaped valley surrounded by hills. It is possible that reflections of the seismic waves due to the local topography could be partly responsible.

The subsurface soils in the La Molina area are considerably less competent than those present in other parts of Lima. Clays and loose sandy soils are reported to be about 100 meters deep under the valley floor. Boring logs indicate that

the top 25 feet of material consist of silt, silty sand and fine to medium sand. The sands are medium dense to dense and the silt layers are loose. Undisturbed soil specimens were not obtained for laboratory testing and standard penetration blow count data were not included on the Log of Borings, therefore, a more accurate assessment of the in-situ density of the soils cannot be made.

Except for a few small cracks in the pavement of a residential street, no evidence was found of any large-scale ground movements in La Molina. Most of the newer buildings at the Agricultural University have been founded on concrete piles. There were no evidences of foundation failures or soil settlements in the vicinity of any of these structures. Several, well constructed, cantilevered retaining walls at the Agricultural University, ranging up to 30 feet high, did not suffer any damage, however, several cracks developed in the ground around the edge of a large concrete water tower due to lateral movement of the tower during the earthquake. Compaction of loose sands under the foundations of the Reina de Los Angeles School in La Molina contributed to the damage at this location.

It was reported that the La Molina area has always experienced higher intensities than other parts of Lima. The aftershock of Nov. 9, 1974 produced a strong motion record at the Agricultural University in La Molina. Another record of this aftershock was obtained at the Geophysical Institute in central Lima (Fig. 2). Analyses of these records and other data may help to answer some of the questions as to why intensities are amplified in this area.

The higher intensities in the Chorillos, Barranco and La Punta areas of Lima are also difficult to explain, considering the data available to the RT. In the areas outside of Lima, it is estimated that the greatest intensity occurred near Chilca, about 60 Km south of Lima.

There were important differences between the intensity distribution in this (1974) earthquake as compared to the 1970 Peru earthquake although they had similar magnitudes. In 1970, the magnitude was 7.7 and the epicenter was located in the Pacific Ocean about 60 Km from both Casma and Chimbote. Focal depth was 25 Km. Reference 3 gives intensities of VIII for Casma and Chimbote, where adobe dwellings suffered almost total destruction; and VII to VIII for Huaraz, located high in the Andes, about 160 Km from the epicenter. In Huaraz, almost all adobe dwellings collapsed killing almost 10,000 inhabitants. Liquefaction, subsidence and landslides occurred for a considerable distance along the coast in the 1970 shock and a bridge was moved off of its rocker supports. The intensities in Table 2 and damage descriptions in this report indicate lower intensities, at similar epicentral distances, for the 1974 earthquake.

Soils

- There was very little soils-related damage. There were no spectacular effects such as liquefaction or the massive landslides that have occurred during previous Peruvian earthquakes. This may be due, in part, to the water table being located at a considerable depth below the ground surface and the soils being quite firm within most of Lima.

Personal inspection of some of the damage indicated the following soils-related effects:

- 1) Intensity amplification in the La Molina area.
- 2) Damage to structures as a result of compaction of loose foundation sands at the Reina de los Angeles School in La Molina.
- 3) Settlement of several overpass approach fills on the Central and Pan American Highways.
- 4) Buried water pipe damage in Chorillos.

Cut slopes, estimated to be 45 degrees, occur along the Pan American Highway near Asia (100 Km south of Lima). Exposed material is loosely consolidated gravel and boulders, however, no landslides were observed.

Buildings

In the Lima Metropolitan area, (Fig. 2) the overall damage to buildings was slight, except for several pockets of moderate to serious damage. In the central or downtown area, even the older adobe and unreinforced masonry structures fared well with only an estimated 5 or 10 percent suffering moderate damage such as collapsed walls. Inspected, modern, high-rise buildings suffered no structural damage and only superficial non-structural damage. Some elevators were rendered inoperable due to the interruption of electrical power and to the counterweights being thrown out of their guide systems.

The pockets of increased building damage are located in the Chorillos, Barranco, La Molina and La Punta areas of Lima. It is estimated that up to 50 percent of the older adobe and unreinforced masonry buildings in Chorillos and Barranco suffered partial collapse. Severe damage and partial collapse of several modern, engineered, buildings occurred in Chorillos, La Molina, and La Punta (Naval Academy).

A modern, engineered, one-story industrial building slightly south of Ancon (Textil San Pedro) lost some of its exterior precast concrete wall panels. These panels were connected to the cantilevered ends of precast roof members by

welding together reinforcing bar inserts in the panels and the roof members. The performance of similar connections in past shocks has been poor. A contributing cause of failure, in this instance, may have been vertical motions induced into the roof members which caused their cantilevered ends to rise and fall producing unusual loads in the panel-to-roof connections.

A new (1972) reinforced concrete framed and pile supported telephone Central Office building in Chorillos suffered severe structural damage. This was the only reported damage among several similar telephone buildings in Lima. One part of this building was designed for two stories but only about one-half of the first story was built. Temporary plywood wall panels between concrete columns were used on the side where future expansion was planned. The opposite wall had unreinforced brick filler walls with their tops about one-half meter below the soffits of the concrete roof spandrel beams. All of the columns along this wall were shattered in the areas above the brick walls due to the much greater rigidity of this wall compared to the opposite temporary wall. Masonry filler walls in the other two end walls were cracked and shattered. Equipment performance at this location was good and is described below in Lifeline Systems.

The La Molina area, located in the eastern suburbs of Lima (Fig. 2), is a relatively new residential area with several modern educational institutions.

Several engineered buildings at the Agricultural University in La Molina suffered severe damage and partial collapse. The RT obtained construction drawings of several of these damaged buildings and RT members are making detailed analyses. Among these are two, similar, one-story classroom buildings with reinforced, poured-in-place, concrete roofs and frames. It was reported that 0.10g was considered in the lateral force design. Foundations are concrete piles but the pile plan configuration did not match the building as constructed and foundation tie beams were introduced at the end bays to compensate for the resulting eccentricities. The rigidity of these tie beams coupled with the additional piles at the two end bays caused these two bays to resist about 2/3 of the total lateral forces in the transverse direction. Column failures and roof collapses occurred in the end bays of both buildings.

The Student Union at the Agricultural University is a two-story concrete frame structure designed for an ultimate height of four stories. Foundations are concrete piling. Anti-seismic design was reported to have considered an .08g lateral force. A single elevator was installed in a four-story shaft. The shaft was enclosed with two temporary and two permanent concrete walls. The permanent shaft walls failed perpendicular to their planes and the shaft shifted about one foot at the temporary roof level. It has been reported that this shaft collapsed in the aftershock of Nov. 9, 1974. Most of the rectangular,

second-story columns exhibited distress in their weak direction at about mid-height, one failed in shear, and one hinged at its base. Column ties are 3/8 inch in diameter, spaced at 30 cm with six ties at 10 cm spacing at the tops and bottoms of each column. These additional ties undoubtedly improved the performance of the columns. Unreinforced hollow tile partitions were separated from the structural frame by about 1 cm and these spaces were filled with compressible strips. These partitions suffered very little damage. Plastic covers for fluorescent light fixtures did not have safety chains and many fell to the floor.

Four, virtually identical, two-story classroom buildings suffered damage in the 1966 earthquake. These buildings have reinforced concrete frames and infilled unreinforced masonry walls. Strengthening, after the 1966 earthquake, consisted of adding reinforced concrete shear walls in the transverse direction. Damage in this (1974) shock occurred at the boundary connections of these concrete panels and to the adjacent columns. There was also considerable cracking in the original second-story end walls.

There are two, large area, one-story concrete, hyperbolic paraboloid, structures at the Agricultural University. Reinforced concrete columns are about 18 cm square. Unreinforced masonry partitions were damaged in the 1966 earthquake and were cut back from the columns about 2 to 4 cm. These spaces were filled with a soft, sponge-like material. This repair was successful in reducing damage in this (1974) earthquake when one building suffered virtually no damage and the other had cracks near the tops of most columns. Unanchored equipment in a machine shop in one of these buildings showed no evidences of movement.

At the Villa Maria College, located at the east side of the La Molina Valley, several classroom buildings were apparently undamaged. One concrete framed classroom building suffered damage which is attributed to a continuous skylight opening at the edge of the roof diaphragm. The main building at this complex lost some adhered brick veneer. Considerable suspended ceiling tiles fell at this location.

The Reina de Los Angeles School, located east of the Agricultural University in the La Molina area, suffered failures of reinforced concrete columns. Foundation soils are soft sand. The damaged columns are located at the ends of the transverse masonry filler walls between classrooms. These filler walls tried to resist most of the lateral loads until they failed and caused failures in the adjoining columns. A contributing cause of damage was the compaction of the loose sands beneath the foundations. This school had suffered damage in previous earthquakes and repairs appeared to be superficial.

A large grain elevator in the port area of Callao lost its headhouse which fell from the tops of the silos and embedded itself in the adjoining pier. It was reported that this elevator suffered damage in the 1970 earthquake and was considered unsafe.

The Lima press reported the collapse of a building at the Naval Academy in La Punta. This facility was inspected by the RT but is not being reported on in deference to a request of the commandant.

Two modern high-rise buildings in Lima were inspected. One of these was the Sheraton Hotel (Fig. 2) where the RT was housed. This is an 18-story reinforced concrete structure and the only damage was slight cracking at the perimeters of the filler walls. There was no damage to the mechanical equipment on the roof but all of the seven elevators were inoperable immediately after the earthquake because the counterweights were thrown out of their guides. This was quickly repaired. An emergency electrical generator performed satisfactorily.

Another inspected high-rise was the 21-story Petroperu building (Fig. 2) which was built in 1973. This reinforced concrete structure has concrete shear walls. Damage was negligible. Elevators and other equipment were not damaged. A few contents were overturned.

Many of the newer dwellings in Lima are constructed with fired brick bearing walls and reinforced concrete wall columns poured in each corner and at wall intersections. No damage was observed to this type of construction.

Glass damage was noted throughout Lima and was caused by: (1) glass being set in putty which upon setting becomes very hard and brittle and (2) excessive deflections of adjacent framing members due to torsion and moment frame actions.

In the coastal villages south of Lima the construction is mostly one and a few two-story and higher adobe and "Quincha" dwellings. A quincha wall consists of vertical poles placed a meter or two apart, usually braced at the bottom in the plane of the wall, with a horizontal cap pole tied to the tops of the vertical poles. Two or three equally spaced horizontal canes are tied to the vertical poles to form the basic framework. Canes are then placed vertically, tightly spaced and woven between the horizontal canes into a basket weave. Both sides of the wall are then plastered with mud. The roof construction may be similar to the walls, thatched with grass, or covered with corrugated iron sheets.

Quincha wall construction is quite light and flexible compared to adobe walls and, in general, the quincha fared better than the adobe. The amounts of heavily damaged adobe dwellings varied from an estimated 70 to 80 percent in Chilca

to less than 10 percent in San Vicente de Cañete. Several larger buildings in Cañete, which apparently contained some degree of integrity, suffered no visible damage.

Lifeline Systems

The overall earthquake performance of the lifeline systems in Lima was good. Little, if any, interruptions of service resulted and all systems were in operation during the RT visit.

The Lima water system is supplied by the Rimac River and about 130 deep wells. There is a treatment plant and about 50 elevated concrete storage tanks. Distribution is by reinforced concrete, cast iron, and cement-asbestos pipes. Some damage occurred at the treatment plant, consisting of settlements of earth dikes and cracking of concrete reservoir walls. However, the operability of this facility was not seriously impaired. Three of the 50 elevated tanks were reported to have suffered slight cracking. No damage to wells was reported. One large pipe was broken (previously cracked) near the central area and about 25 breaks occurred in smaller cement-asbestos pipes in the Chorillos area.

No damage to the Lima sewage collection system was reported. There are no treatment facilities. There are two ocean outfalls, one north and one south of Lima (Fig. 2).

The Lima electrical power system suffered only minor damage with a total reported loss of about \$110,000. The majority of the low voltage distribution system is underground. Power was interrupted for about 1/2 hour due to the tripping of relays at generation plants. There are only a few emergency electrical generating plants, mostly in government facilities and large hospitals.

Telephone Communications in Lima were not interrupted by the earthquake. The anchorages of the top bracing of equipment racks at the Chorillos Central Office were damaged but the equipment did not fall over and continued to operate. Batteries and battery racks, emergency generators, and generator fuel supplies at this location are well anchored and braced and were not damaged. Telephone service between Cañete and Lima was interrupted for about 8 hours due to damage to connecting lines. The Cañete Central Office continued to operate in a damaged building by the use of an emergency, diesel-electric, generator. No damage to long distance microwave equipment was reported.

Radio and TV stations were operating during the RT visit and newspapers were available.

Two petroleum refineries were inspected. The Pampilla refinery, north of Lima (Fig. 1), suffered only slight damage.

An "elephant foot" bulge occurred near the bottom of the wall of one steel storage tank and several concrete piers, supporting LPG spheres, were cracked. The Conchan refinery, located south of Lima (Fig. 1), was damaged only slightly more than the Pampilla facility. One tank bottom split allowing the contents to leak into the dike area and oil spilled from one floating top tank. Several earth dikes settled about 2 to 4 cm. However, a free standing old concrete block fence about 2-3 meters high was not damaged and a loose stack of bricks about 2 meters high and 1/2 meter square did not fall over!

All roads, freeways and bridges were reported to be operable. Some slight settlements of bridge approach fills were noted. No damage to railroads was reported. The terminal building at the Lima Airport suffered slight damage but no damage to the runways was noted and the facility was operational

PRELIMINARY CONCLUSIONS

1. The important influences of site amplification on building damage were again emphasized. Strong motion records obtained from the main and aftershocks, together with other data, may help us to better understand this problem.
2. There were no significant new engineering lessons learned in this moderate intensity earthquake. However, following are several important old lessons which were re-learned:
 - a. The Poor performance of unreinforced adobe, brick, and hollow tile bearing wall buildings in even moderate intensities.
 - b. The Poor performance of reinforced concrete moment frames. Some ductility provided by closely spaced ties at the ends of columns generally improved performance in these areas.
 - c. The influence of filler walls in attracting lateral forces which result in damage to the walls and adjacent frame members.
 - d. The Poor performance of precast concrete construction. The possibility of vertical movements should be considered in the design of connections between elements.
 - e. The good performance of reinforced concrete shear walls and the newer brick and reinforced concrete dwelling construction.

f. The good overall behavior of community life-line systems and well anchored and braced equipment. The good performance of buried conduits in relatively good soil.'

g. The deteriorating effect of unrepaired, cumulative earthquake damage must be considered when evaluating current damage.

REFERENCES

1. Lomnitz, C. and R. Cabré, S.J., "The Peru Earthquake of October 17, 1966", BSSA, 58-2, p. 645, April, 1968.
2. Lomnitz, C., "Preliminary Note - The Peru Earthquake of May 31, 1970", BSSA, 60-4, p. 1413, August, 1970.
3. Stratta, J. L., et.al., "Preliminary Report, Peru Earthquake of May 31, 1970", EERI, 1970.