THE SAN FERNANDO EARTHQUAKE

What It Did to Structures

A report by Caltech's earthquake engineers

At 6 a.m. Tuesday, February 9, 1971, the strongest earthquake to strike metropolitan Los Angeles in this century occurred in the northern San Fernando Valley. The magnitude 6.6 earthquake was not a large earthquake in the seismological sense; earthquakes of this magnitude occur at an average rate of 30-40 per year on the earth, and on the average of about once every four years in the southern California area. From the engineering point of view, however, the earthquake was a very large and important one because it was located at the edge of a densely populated urban area, and the region of heaviest ground motion contained an unusually large number of such critical installations as hospitals, dams, electrical switching and converter stations, and freeway interchanges. Some 400,000 people were subjected to very strong ground shaking, and an additional 2,000,000 to moderately strong motion. Furthermore, the particular

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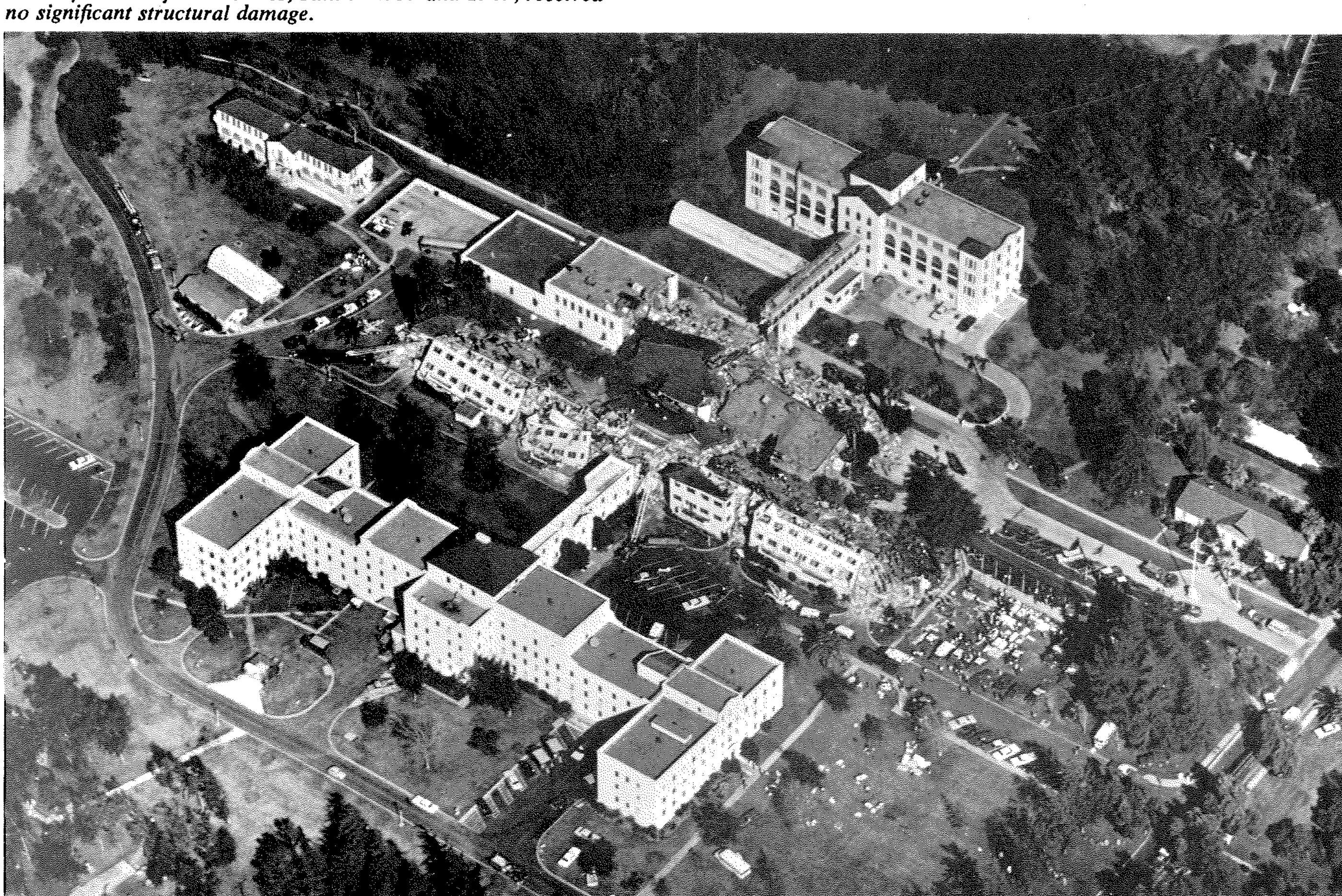
An aerial view of the Veterans Administration Hospital in Sylmar on the morning of the earthquake. The collapsed structures in the center were built in 1926, before earthquake-resistant design procedures were reflected in the building codes. The adjacent major structures, built in 1937 and 1947, received no significant structural damage.



– One of the Most Important in History

What It Did to the Earth

A report from Caltech's seismologists

Until 1971, seismic activity in the San Fernando Valley area had been low to moderate—as it was in many other parts of California. Certainly there was nothing in very recent seismic history to suggest that this area was more likely than any other to experience a magnitude 6.6 earthquake. Caltech has kept track of the epicentral locations of southern California earthquakes since 1934—the epicenter of an earthquake is the point on the surface of the earth above the subsurface point where the initial breaking occurs. In the last 34 years only about 10 earthquakes of magnitude 3.0 or greater have occurred in the epicentral region of the San Fernando earthquake. None of these tremors was considered large, although a few were felt locally, such as the magnitude 4.0 shock on August 30, 1964, that was centered under southern San Fernando.

Previous to 1934, two shocks in this vicinity are of particular interest. One—with a magnitude of 5.2—occurred on August 30, 1930. It was probably much closer to the San Fernando area than the original epicentral assignment in the Santa Monica Bay suggests, and it is significant because it caused some very minor damage to the lower Van Norman dam, which was severely damaged by the 1971 event.

Of much greater significance, in terms of its similarity to the recent San Fernando earthquake, is the Pico Canyon earthquake of 1893. Pico Canyon is just three miles west of Newhall, which was heavily shaken by both the 1893 and the 1971 quakes. The Pico Canyon temblor probably originated slightly west of the epicenter of the 1971 earthquake, and it certainly indicates that moderate earthquake activity is not new to the region. Nevertheless, it is clear that the 1893 event was smaller than that of 1971.

In the light of these past events, the San Fernando quake emphasizes the fallacy of assuming that the largest shock experienced in the past in any given area is necessarily typical of the largest shock to be expected there in the future. Since an earthquake of at least the magnitude of this one (6.6) occurs somewhere in southern California about once every four years, the February 9 earthquake was no great surprise. An earthquake of about this same magnitude occurred in 1968 in the Borrego Mountain area about 137 miles southeast of Los Angeles, but damage was small because—unlike the 1971 event—it took place in a sparsely settled area.

A reasonable geologic model developed by Caltech for the San Fernando earthquake reveals ground displace-

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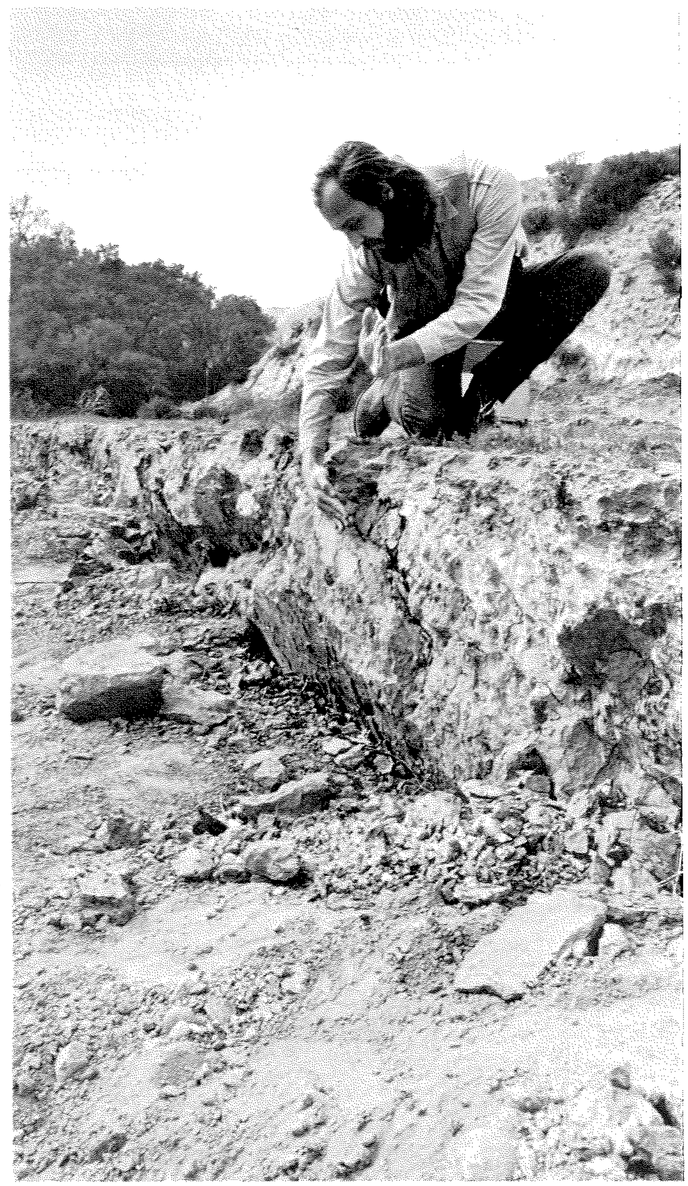
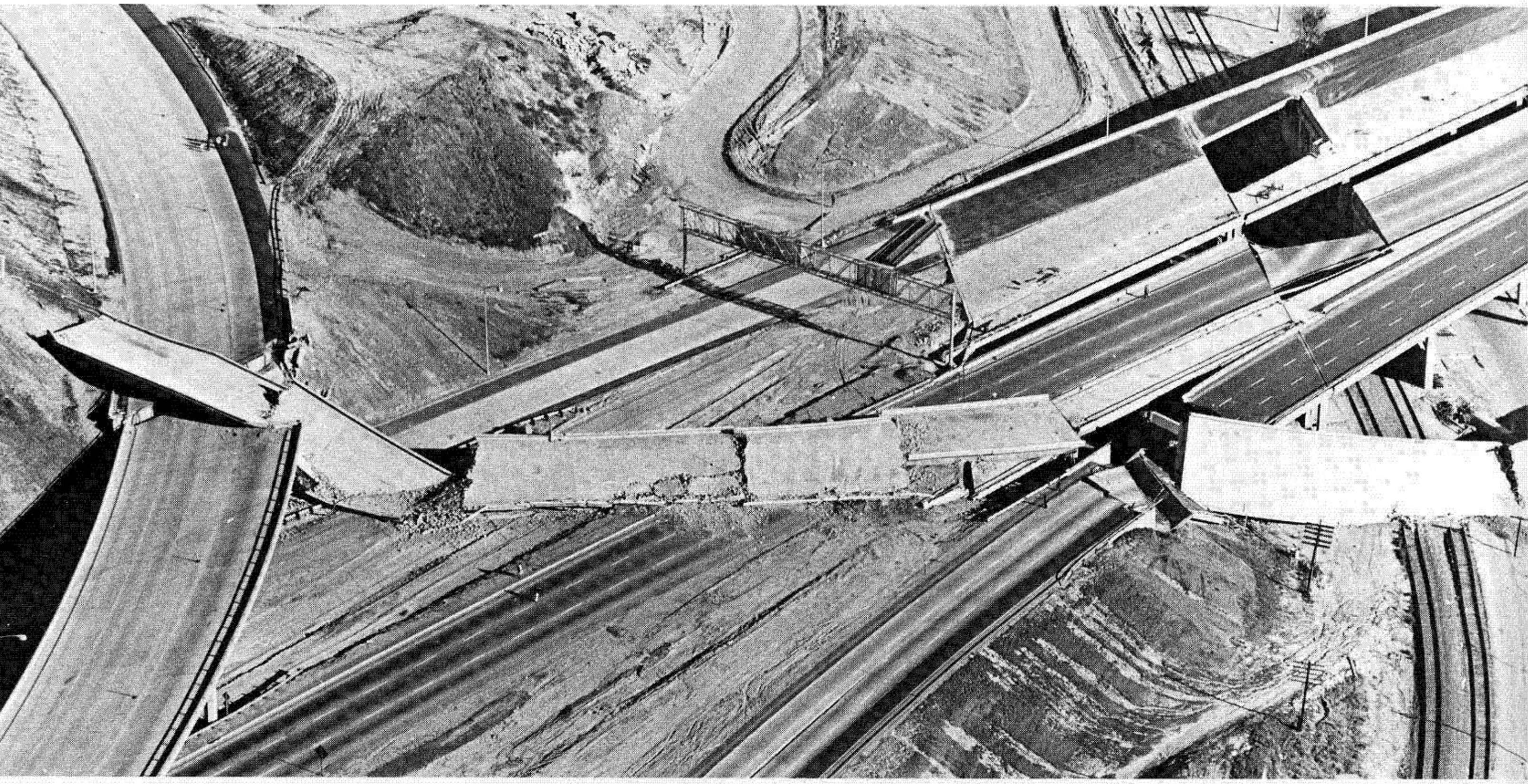


Wayne Thatcher, geology graduate student, examines a fault scarp in Lopez Canyon after the quake. It was this displacement —in which the right-hand or north side of the fault moved up about 3 feet—that caused the quake.



This is one good reason why earthquake engineers feel there are many improvements that can be made in highway structures. Nearly every bridge and overpass structure in the interchange between the Foothill and Golden State freeways was seriously damaged by the earthquake.

type of overthrust faulting that occurred resulted in a release of earthquake energy at an unusually shallow depth. Many of the heavily damaged facilities were virtually on top of the earthquake and were subjected to severe shaking.

The estimated cost of the damage caused by the earthquake is in the vicinity of one-half billion dollars.

The major loss of life occurred at the Veterans Hospital in Sylmar where a concrete frame, tile-wall, pre-earthquake code hospital building collapsed, killing 44 people. Another 11 were killed elsewhere, including 2 crushed by a collapsed freeway overpass, and an additional 9 were reported to have died from heart attacks.

Four major facilities in the central region of the shock suffered severe damage: the new Olive View Hospital (initial cost $27 million); the Sylmar Converter Station of the Pacific Intertie (this large electrical switching and rectifying station had an initial cost of about $110 million); the Metropolitan Water District's new, large underground reservoir; and two earth dams at the Van Norman reservoir site (constructed in 1915 and 1928).

There was also severe damage from ground movements to the $6.5 million San Fernando juvenile facility, and vibrational and ground-movement damage to numerous one- and two-story industrial and commercial buildings in the San Fernando Valley. Some buildings in the eight- to fifteen-story range in North Hollywood suffered structural damage. In addition to the Veterans Hospital at Sylmar and the Olive View Hospital, the Pacoima

Lutheran Hospital, the Holy Cross Hospital, and the nearby Indian Hills Medical Center (an office building) all received serious structural damage. The most severe industrial damage occurred near Newhall where a glass factory suffered approximately $10 million damage. Nonstructural damage, including broken glass, fallen light fixtures and ceilings, and plaster cracking occurred throughout the San Fernando Valley and also in the adjoining areas of Glendale, Pasadena, Los Angeles, and to the north at Newhall and Saugus.

An estimated $30 million damage was done to bridges and overpass structures on the Golden State, Foothill, San Diego, and Antelope Valley freeways. Particularly hard hit were the interchange between the Golden State and Antelope Valley freeways and the interchange between the Foothill Freeway and the Golden State Freeway. Bridges on the Antelope Valley and Foothill freeways in the epicentral area also received serious damage.

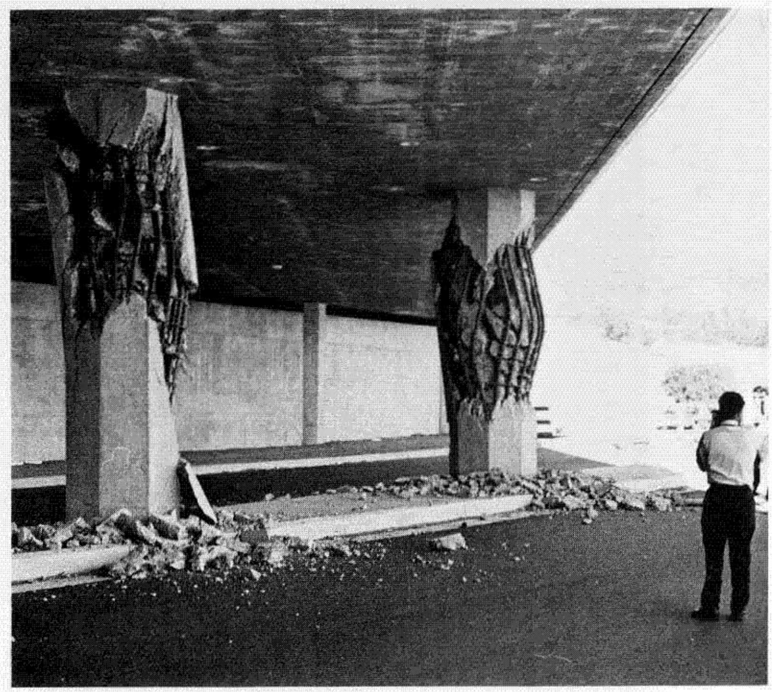
Permanent ground displacements caused extensive disruption to underground utilities in parts of the San Fernando Valley, especially where surface faulting occurred. Gas lines were ruptured in several areas, and water and sewer lines also were fractured, affecting service to thousands of homes. Telephone service was lost to ten to twenty thousand customers in the epicentral area from approximately $4.5 million damage to General Telephone's central facility in Sylmar. Emergency communications were hampered by a power outage at police headquarters and by destruction of the radio facility at the Veterans Hospital.

The faulting and the ground movement, combined with the shaking, damaged thousands of homes, and hundreds were damaged to the point where they no longer could be occupied. Chimney damage was the most common vibrational damage and occurred as far away as Pasadena.

Old, weak buildings in downtown San Fernando and as far away as Pasadena, Los Angeles, and Santa Ana suffered significant damage, usually in the form of falling masonry. Two people were killed by failure of old buildings in downtown Los Angeles. Caltech's oldest building, Throop Hall, suffered extensive cracking to the nonstructural tile filler walls and to the exterior facing. No structural damage to it occurred in this earthquake, but Throop Hall falls well below modern standards, and its eventual fate has not yet been decided.

Although the earthquake damage was severe, there were several factors which limited the disaster the earthquake might have caused. First, the area subjected to the most damaging shaking was of small size, and it was immediately adjacent to a relatively undamaged urban area containing extensive fire, police, medical, and other service facilities. These services were adequate to cope with the situation without becoming seriously overloaded.

A second fortunate factor was that most people were



Columns on the Foothill Boulevard overcrossing of the Foothill Freeway were severely damaged. The complex failure of the bridge was aggravated by the inadequacy of the ½-inch horizontal ties that were supposed to confine the 2¼-inch-diameter vertical reinforcing steel.

in their homes at the time of the earthquake, and the type of residential construction common here is highly resistant to earthquake destruction. The typical light and strong wood frame house may be seriously cracked and damaged, but it seldom collapses completely with a major threat to life and limb. Only a very few, perhaps two or three, people were killed in their homes during this earthquake. If the shock had occurred just three hours later, the collapsed Psychiatric Day Care Center at the Olive View Hospital would have been occupied, the freeway overpasses would have collapsed on lanes of traffic, and the falling debris from old buildings in San Fernando and Los Angeles would have pelted busy sidewalks. The resulting casualty toll would have been much more severe.

Another favorable factor was the lack of major landslides in densely populated areas. Such slides were a major source of damage in the Alaskan earthquake of 1964 and in the 1970 Peruvian earthquake, in which one major rock and ice avalanche buried two towns, with an estimated 20,000 deaths. Fortunately, the possibility of such slides in the Los Angeles area seems small.

By far the most fortunate escape from disaster was the survival of the two Van Norman dams which were both

The luckiest feature of this earthquake was the survival of the lower Van Norman dam—which looked like this on the morning of the quake. A major section of the dam slid into the reservoir, leaving a scarp of about five feet between the water level and the top of the remaining portion of the dam.

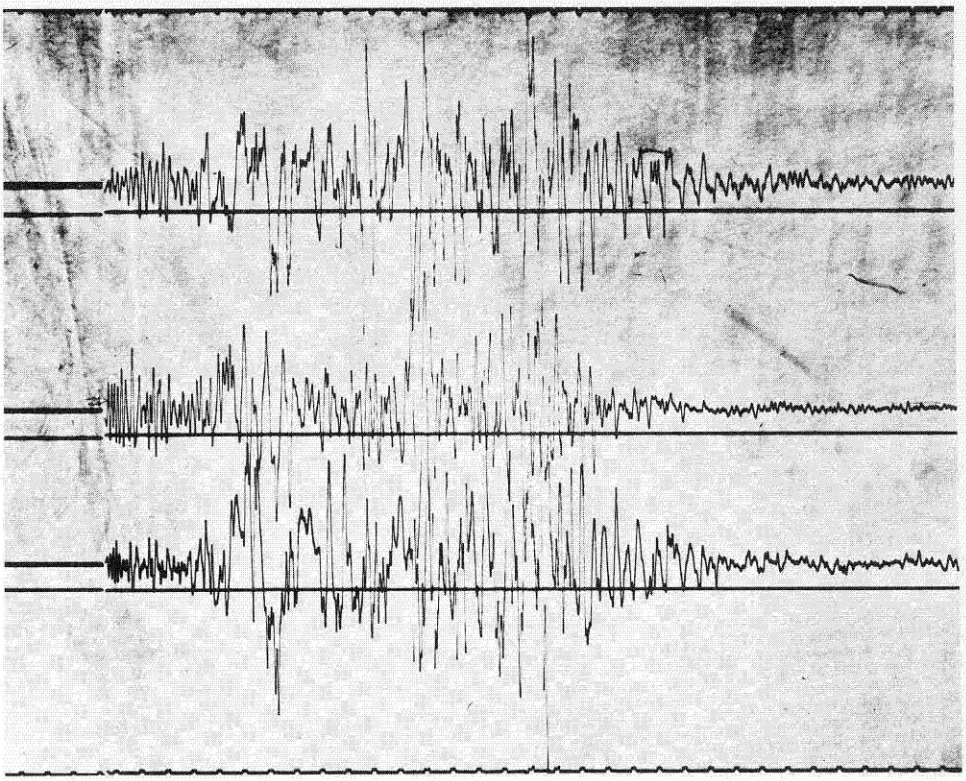
severely damaged by the earthquake. The dams very nearly failed, and had the ground shaking lasted a little longer or had it been a little stronger, a catastrophic flood would have swept through a densely populated region before the inhabitants could have been evacuated. This is perhaps the most frightening aspect of this earthquake.

On the positive side, the earthquake provided a large amount of valuable data on ground and building motions that will notably increase engineering knowledge of earthquakes. Some 200 accelerographs recorded earthquake motions at various locations—on the ground, in buildings, on dams, for example. These accelerographs, maintained by the National Oceanographic and Atmospheric Administration's National Ocean Survey and Caltech's Earthquake Engineering Research Laboratory, provided by far the greatest amount of strong-motion data so far recorded in any earthquake. Included in these results is the strongest ground shaking ever recorded. The record was obtained in the middle of the epicentral region on a steep rock ridge near the south abutment of Pacoima Dam. The concrete arch dam was not damaged.

The large collection of records obtained in the earthquake is extremely valuable from the point of view of research. For the first time there is enough data on the character of the ground motion and the response of structures to strong shaking to begin to answer some of the fundamental questions in earthquake engineering research. Such questions include how much the local geology affects ground motion, and what level of energy dissipation occurs in buildings under strong shaking.

The information gained from the San Fernando earthquake will aid greatly in efforts to reduce the disaster potential of future strong earthquakes. Many detailed studies are now under way to clarify particular features of the earthquake damage and to recommend ways to avoid damage in future shocks. Detailed recommendations and conclusions must await the results of careful study, but some general lessons of the earthquake are already apparent:

(1) A striking consequence of the earthquake was the fact that four hospitals in the San Fernando area were damaged so severely that they were no longer operational just when they could have been needed most. Critical structures such as these should be designed so that they remain functional after experiencing the most severe ground shaking. Included are hospitals, schools, high-occupancy buildings, and buildings housing police and fire departments and other agencies relied upon to cope with disasters. In addition to the structures, the emergency communication systems of these agencies must receive special care so they will not be damaged. Basic utilities that must be depended upon for the life of the community must also receive an extra measure of protection.



This accelerogram retrieved from the Pacoima Dam represents the strongest earth motion ever recorded. The single largest deflection in each band represents an acceleration of one full g, and several deflections indicate 60-70 percent g.

Ordinary building codes cannot be depended upon to preserve these functions, and special code provisions are necessary.

(2) This earthquake has provided the first really comprehensive practical test of U.S. earthquake codes. Modern structures designed according to earthquake requirements of the building code performed well in the regions of moderately strong ground shaking. In the region of very strong ground motion, however, some modern buildings were severely damaged, and the few that collapsed would have caused many additional deaths had they been occupied at the time. If the duration of strong ground shaking had been appreciably longer, as it would be in a great earthquake, some of the severely damaged structures would almost certainly have collapsed. It is clear that existing building codes do not always provide adequate safety against collapse, and such codes should be reviewed in detail and updated to include the latest practical developments in earthquake engineering.

(3) Many old, weak buildings in the regions of strong and moderately strong shaking suffered severe damage, and the major loss of life occurred in one old building designed before the adoption of modern building codes. There are many thousands of such old buildings in California that will collapse if subjected to strong ground shaking. Programs should be undertaken to render such buildings safe, or to raze them, over a reasonable period of time. A successful effort of this type has been under way for some time in the city of Long Beach, and in the city of Los Angeles especially hazardous parapet walls

on several thousand buildings have been removed or strengthened. The San Fernando earthquake dramatically demonstrated the value of such procedures. A much more extensive program to eliminate the major hazards of old buildings is needed.

(4) The near catastrophic failure of the lower Van Norman dam endangered the lives of tens of thousands of people. Such risks are clearly unacceptable. Inasmuch as many existing dams in all parts of the country have not been designed to resist earthquake forces, a program for bringing older dams up to modern safety standards is imperative. Such structures should be thoroughly examined and measures taken to reduce such hazards to an acceptable level. The successful performance of a new earth-fill dam at the Van Norman site shows that modern earth-fill construction can withstand the earthquake forces that damaged the older dams.

(5) A number of freeway overpass bridges collapsed, causing two deaths and resulting in major disruptions of traffic. In a great earthquake, such interruptions of transportation could greatly magnify the disastrous effects of the earthquake. Freeway bridges, and important highway bridges, should be designed for adequate safety

The damage to the new Olive View Hospital was the most significant feature—from the structural engineering point of view—in this quake. The damage here was not caused by faulting under the structure (as has been suggested), but by ground shaking.

against collapse. Present standard code requirements for earthquake design of highway bridges are inadequate and should be revised in conformity with the current state of knowledge in earthquake engineering.

(6) It is noteworthy that, in the region of strong shaking, school buildings designed and constructed under the Field Act of the California State Legislature did not suffer structural damage that would have been dangerous to the occupants had the schools been in session. This demonstrates that one- and two-story school buildings can indeed be made safe by practicable code requirements even when such buildings are subjected to very strong shaking combined with appreciable ground deformations beneath the structures. On the other hand, older school buildings that did not meet the requirements of the Field Act suffered potentially hazardous damage in regions of only moderately strong ground shaking. The lesson is clear that such hazardous school buildings must be eliminated or strengthened.

(7) None of the tall buildings in Los Angeles was seriously damaged by the earthquake, but it should be emphasized that this earthquake was too far away from downtown Los Angeles to be a good test of the strength of these structures. Tall buildings, like other buildings, can be made to resist the strongest shaking without collapse, but this does not occur automatically. Unless the special care devoted to the design of recent tall buildings is continued in the design of others, tall buildings, too, can be a hazard in the event of strong shaking.

(8) The extensive damage to electrical transmission facilities shows that the earthquake-resistant design of these facilities must be markedly improved. It has been estimated that it will be at least a year before repairs are completed at the Sylmar Converter Station, which suffered approximately $30 million damage.

(9) The approximate damage cost of $500 million and the effects on vital services from a moderate earthquake occurring on the fringe of the Los Angeles metropolitan area point out the large disaster potential of major earthquakes. If the shock had occurred near the center of the city, or if a great earthquake should occur on the San Andreas fault, it would seem that the damage could approach three or four billion dollars, and essential services would be severely crippled. The rapid recovery from the San Fernando earthquake showed that the disaster was not too large for the recuperative powers of the metropolitan area to overcome; the utilities, medical, and protective systems handled the increased burden very well; and relative normalcy has been approached in a matter of days or weeks. It is not expected, however, that such systems could overcome the consequences of a great earthquake without major assistance from outside the metropolitan area.

(10) The San Fernando earthquake again demonstrated that the most practical approach to the problem of safety in earthquakes is earthquake-resistant design.

Nearly all the bookshelves collapsed on the upper stories of Caltech's Millikan Library, and about 75,000 books spilled to the floor. The accelerograph at the base of the library recorded a maximum acceleration of 15 percent g, and the instrument at the top of the building showed about 35 percent g.

Structures can be designed to withstand safely the most severe earthquakes, but this cannot be done without an increase in cost. For many buildings and other structures, this increase in cost is a modest one; for others it may represent a significant increase in over-all investment. Once essential function and safety of life and limb have been assured, the problem of earthquake-resistant design becomes an economic problem; the initial cost must be balanced against the possible cost of repair to earthquake damage over the expected lifetime of a structure.

The San Fernando earthquake, though a disaster to many, has provided a unique opportunity to learn about the effects of strong earthquake motion. The results of the many engineering studies now under way, and the actions and regulations prompted by this earthquake, should reduce significantly the hazard from earthquakes of the future.

This article was written by the staff of Caltech's Earthquake Engineering Research Laboratory in the Division of Engineering and Applied Science. Contributors include George W. Housner, Donald E. Hudson, Paul C. Jennings, Ronald F. Scott, Wilfred D. Iwan, Mihailo D. Trifunac, Gerald A. Frazier, Arthur G. Brady, and John Wood.

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ment that began at a depth of about eight miles beneath the epicenter (located about 7½ miles east of Newhall). It then moved southward and upward along a fault plane that slanted at an average angle of 45 degrees, and actually broke the surface of the ground in the Sylmar-San Fernando area. This kind of a fracture, known as a thrust fault, is typical of the faults that had been mapped by geologists in this area prior to the earthquake. However, the particular fault that broke on February 9 had not been recognized as being especially active, and there was no obvious reason to consider it more dangerous than the many other similar-appearing faults throughout the Los Angeles region.

Investigations of the earthquake area indicate the presence of a combination of land movements. Some was of the strike-slip variety, in which the northern block moved to the west relative to the southern block. Combined with the strike-slip movement—and probably dominant over it—was the overthrust movement in which one block went up and over the opposite block.

In the San Fernando earthquake, the San Gabriel Mountains (the northern block) moved in a thrust-like motion southwestward over the San Fernando Valley floor (the southern block) along a fault plane that slants shallowly back underneath the mountain range. Preliminary estimates indicate that the mountain block rose up at least three feet in relation to the valley floor and moved at least three feet to the south.

When the fault met the surface, it produced a great deal of ground shortening. As much as six feet of shortening took place across the Sylmar fault trace—the fault trace is the line where the fault surface outcrops on the surface of the earth. Such ground displacement extended over a wide zone, buckling streets and sidewalks and causing heavy damage to many structures.

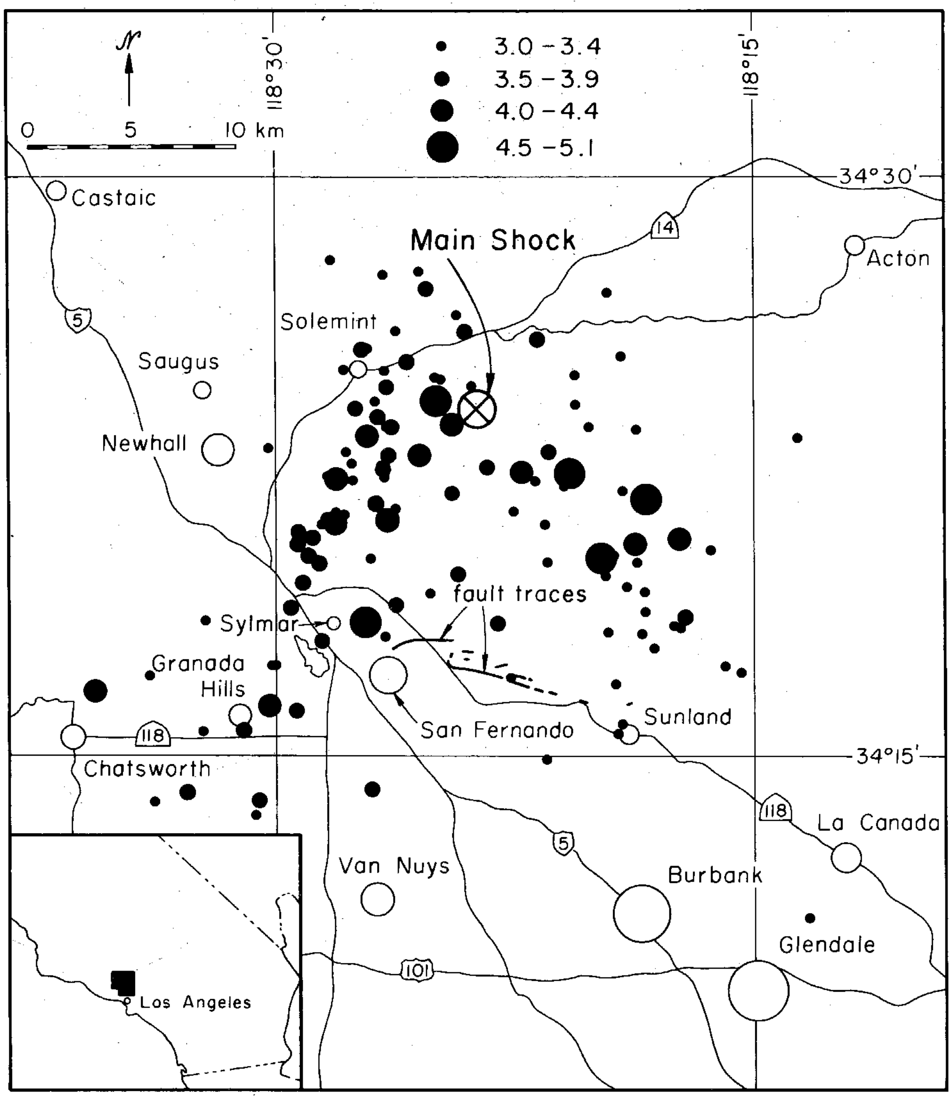
The first large shock to be so thoroughly monitored and recorded, this earthquake is expected to produce more significant and more detailed data than any other earthquake in history, because it occurred very near the center of the southern California seismographic recording network. Caltech's Seismological Laboratory operates an array of 20 permanent recording stations extending from the Owens Valley to the Mexican border and comprising both conventional and special purpose instruments. Seismic records produced at eight of the stations, six of which are operated directly by Caltech and two by the State Department of Water Resources, were relayed by microwave to the Seismological Laboratory in Pasadena where instantaneous readings were made. The records from the remaining 12 stations are made photographically and are mailed to the lab once a week for processing and evaluation. Since February 9, this network has detected and recorded over 200 aftershocks of magnitude 3.0 or greater.

Aftershocks of earthquakes are usually distributed over a wide area that is more or less centered on the area of the fault that originally breaks. The aftershock sequence following the San Fernando earthquake seems to be a normal one, and Caltech seismographic records taken before the quake show no indication of identifiable foreshocks. A careful examination of records from the Mt. Wilson seismic station indicates that no shocks exceeding magnitude 1.5 had occurred in the area in the preceding eight days. No shock exceeding magnitude 2.5 had been identified in the area during the preceding four months, and it appears that the most recent identifiable event within the area of subsequent activity was a shock of magnitude 2.6 that occurred north of Sylmar on September 28, 1970.

The greatest concentration of aftershock activity appears to lie roughly in the shape of an inverted U symmetrically disposed with respect to the epicenter of the main shock and to the pattern of the surface faulting. The epicenters of the aftershocks tend to delineate the boundaries of the thrust displacement that caused the quake, although many of the shocks along the western limb seem to represent deeper strike-slip events whose relationship to the main thrust fault is very complex and not yet understood.

Very accurate hypocentral locations have been determined for some 25 of the aftershocks. Hypocenters are the points beneath the earth's surface where the first motion occurs. The deepest of these hypocenters is about eight miles, and the average depth is close to three miles. As has been observed in other aftershock distributions associated with thrust faults, the bulk of the aftershocks following the San Fernando earthquake occurred predominantly in the upper plate of the earth, leaving it more broken up and shattered than the underlying rock.

Since the San Fernando earthquake, many questions have been asked about its possible effect on the "big" earthquake that has long been forecast for the southern portion of the San Andreas fault. These are extremely difficult questions to answer. Southern California is an area with a very complex series of faults that have different directional trends and different styles of



A seismological map of the epicenters of the main shock and aftershocks of magnitude 3.0 or greater that occurred in the month following the February 9 earthquake. The aftershocks occurred in a peculiar inverted U-shape. The hypothesis is that the segment of the fault that broke has this same U-shape. Aftershocks may represent the points where the displacement on the fault actually stopped.

movements, though they fall, essentially, into two major fault systems. One of these systems is composed of the east-west trending ranges like the San Gabriel Mountains and particularly the mountains near Santa Barbara. These mountains are characterized by east-west trending faults that tend to exhibit thrusting of the type observed in the San Fernando Valley earthquake.

The other system is directly related to the San Andreas fault that slices through western California for more than 600 miles, extending in a straight line southeasterly from the Mendocino County coast to the southern San Joaquin Valley; there it bends to the west and then continues southeast along the north flank of the San Gabriel Mountains. Branches of it eventually reach the Gulf of California.

The San Fernando quake occurred within the first system, and its effect on the San Andreas system is still unclear to geologists. But it is believed that the compression along the 50-mile stretch where the San Andreas bends westward may have had some direct relationship with the February 9 earthquake, even though there was apparently no movement along the big fault.

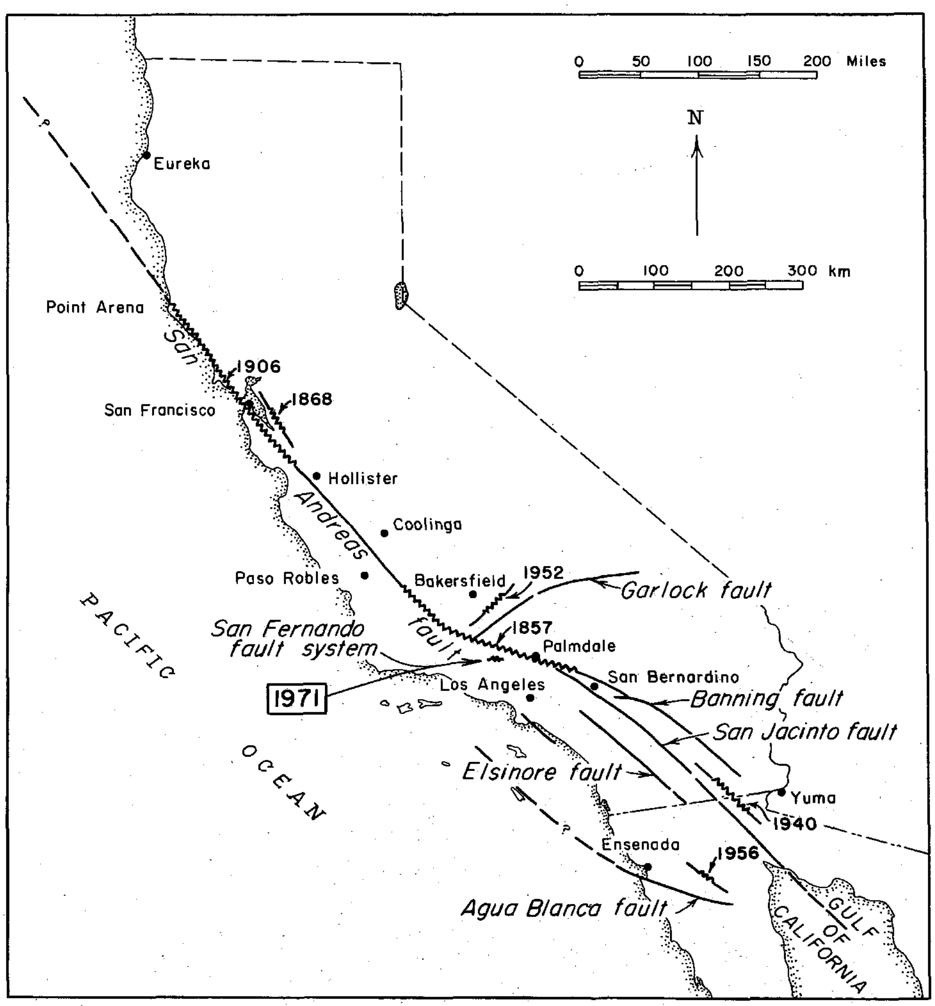
"The bend," says Don Anderson, director of Caltech's Seismological Laboratory, "tends to block and jam the general northwesterly movement (at the rate of about two inches a year) of that part of California that lies west of the San Andreas fault in relation to the rest of the state east of the fault. The fault runs in virtually a straight line both north and south of the bend. In those areas this general northwesterly movement is punctuated by occasional horizontal slipping along the San Andreas and its associated faults, accompanied by earthquakes.

"But near the bend the horizontal slipping gets hung up. The compression builds up, and instead of horizontal movement there is overthrust faulting in that region, with land thrusting over land along fault breaks, triggering earthquakes like the one in San Fernando."

Will the Los Angeles area experience another major quake—this time along the San Andreas? Clarence Allen, professor of geology and geophysics, says, "We know something about the rates at which movements are taking place along the San Andreas fault. We have geodetic observations from surveying in the Imperial Valley and in northern California that give us some clue to the rate at which the shape of California is changing, and if our computations are correct—and there are many assumptions in this—it leads us to believe that an earthquake along the San Andreas fault should occur at an interval of once every 100 to 200 years.

"We last had a break down here in 1857, and consequently our feeling is that a major quake on this, the southern portion of the San Andreas fault, say tomorrow, wouldn't be any surprise. The stresses relieved

Some historic earthquakes on the San Andreas and its associated faults in California and northern Mexico. The zigzag lines show where the ground surface was broken in various earthquakes. The bend in the San Andreas, just north of Los Angeles, may have played an important role in triggering the San Fernando quake.



at the time of the 1857 earthquake have again built up to the point where they deserve attention."

The recent San Fernando earthquake and the continuing discussion about possible quakes along the San Andreas fault have focused new interest on an old question: Can earthquakes be predicted? Among the world's experts there is not much agreement on the subject. Some say precise earthquake prediction is impossible; others say it is possible but will take a long time and a lot of money.

Charles Richter, the inventor of the Richter Scale and Caltech professor of seismology, emeritus, says flatly that it can't be done. Clarence Allen and Don Anderson both agree that predicting earthquakes is an impossible business at the present time, but it is an objective worth working toward. According to Allen, precise prediction is "not something we'll do in the immediate future, but even if we are never able to predict earthquakes in terms of exact time and place, we may be able to reach another objective of great value. That is, through geological and geophysical studies, we may be able to ascertain which areas are likely to have more earthquakes than other areas and what the average frequencies of any given magnitude in those areas will be. This is what the engineers need in order to design buildings safely and economically."

Anderson says that we can't predict earthquakes now except in the sense that we know there have been and will continue to be a lot of them. He feels it is not a problem you can successfully tackle with statistics because the records just don't go back far enough in time.

The primary technical obstacle to achieving a relative prediction capability is a lack of instrumentation. Currently, southern California has only about 30 seismic stations, and they are located about 12 miles apart. Ideally, a grid of many seismographic stations not less than six miles apart would be necessary to keep accurate tabs on the seismic activity in most areas. More importantly, special purpose instruments such as strain gages and tiltmeters are required to monitor the strains before an earthquake.

While the problem of earthquake prediction is still unresolved, it is clear—as everyone was reminded on February 9—that California will continue to have hundreds of earthquakes every year. And some of them will be big ones.

This article is a summary of the early findings from the San Fernando earthquake by the Division of Geological and Planetary Sciences.

Among the many fortunate people who survived the earthquake with a bare margin of safety was Dee Barr, graduate secretary in Caltech's chemistry division. She and her husband, who is the caretaker of the Pacoima Dam, awoke February 9 to find that their bedroom wall had come very close to being crushed by a boulder fallen from the mountain behind their house.