CALIFORNIA PREPARES FOR A GREAT EARTHQUAKE

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SUMMARY

This paper analizes the preparedness of the people of California for the predicted Great Earthquake. It considers the psychology of earthquakes in terms of public attitudes and government attention toward preparedness. It provides a historical review of the accomplishments of the engineering profession in awakening public awareness. It describes the changes brought about by the Earthquake Preparedness Task Force of the California Seismic Safety Commission. It examines the performance of governmental and volunteer forces during the "proving ground" earthquake of May 2, 1983, at Coalinga, California.

HISTORY

It has been traditional for engineers to introduce papers on earthquakes with a recounting of earthquake history. Within this tradition, I have tried to do something different by introducing a syllogistic graph of Richter Magnitudes plotted against lives lost, as shown on Figure (1). At first glance, the graph appears to indicate a totally random or even lack of relationship. However, let us make two adjustments. First, eliminate the San Francisco earthquake of 1906 because its victims were mostly victims of fire, not directly of earthquake. Then eliminate the Anchorage earthquake of 1964 because its victims were mostly victims of tsunami, not directly of earthquake. With these adjustments, the worst killer earthquake becomes the one with the smallest Richter Magnitude--Long Beach, 1933 with a RM 6.3. Thus the graph gives us a clue to public ambivalence toward earthquake preparedness.

PSYCHOLOGY OF DISASTERS

Figure (2) is a tabulation of factors in the psychology of disasters.

Examine their behavior pattern. Note that fires are the most frequent, whereas major earthquakes are the least. Major fires rarely develop in densely populated areas, because of rapid responses by a well developed network of governmental fire departments. On the other hand, destructive earthquakes often occur there.

Fires rarely trap a large number of people at one time. Even a maximum possible fire is not likely to be a great killer. It is because of the frequency of fires, that the aggregate number of victims is frightening. A great earthquake, however, is capable of killing vast numbers of people. There have been many earthquakes with fatalities exceeding a hundred thousand, and two of them with fatalities approaching one million.

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Generally, the number of victims is not proportional to the size of the event. In the case of fire, this is the result of preventive measures and the availability of fire fighting forces. Other natural disasters lack this proportionality because of their geographic locations, warning systems, etc. It is only in earthquakes that the losses are likely to rise exponentially with the size of the event.

Examine the effect of disasters on the TV viewer. TV is a fact of life and delivers the greatest impact on our attitudes by its audio-visual power. People's conception of any natural disaster will be influenced by its exposure on TV. And TV reportage favors the spectacular, the photogenic and the dynamic.

In these respects, volcanoes get first prize, with fires right behind. These events, also, have the persistence of remaining dynamic till the camera crews arrive. Earthquakes, on the other hand, are almost never caught in action, and photographs of after-effects are not dynamic. It is not surprising, therefore, that people consider themselves directly involved in fire danger, whereas other disasters, and particularly earthquakes, happen to someone else, somewhere else.

Yet all disasters affect society and the normal continuity of people's lives. Note that only a great earthquake is capable of adversely affecting the lives and future of the entire nation. As an example: a great earthquake in SF Bay Area could knock out the computer industry. A great earthquake in the Los Angeles-Orange County Area could cripple the aero-space and the audio-visual industries.

How can the planning process reduce the hazard of loss from natural disasters? And, considering people's attitudes, how is it performing this function? Figure (2) shows that retrofit for fire resistance was possible and financially feasible, that there was nationwide response, and that both prevention and remedial action was developed. Seismic retrofit is also possible but tends to be more expensive.

With nearly 20 million Californians, the majority of this state, happily living and working in the immediate vicinity of major fault lines, the engineering profession is worried about the inevitable happening of a great, shattering earthquake somewhere in the San Andreas Fault System.

To all appearances, that is as far as the concern goes. City Councils and County Boards of Supervisors don't seem to be very concerned. The Governor definitely does not seem to be very worried, having vetoed the appropriations for the Earthquake Preparedness Task Force.

It behooves us seismic professionals to analyze and understand the disparity of concern between us and the potential victim population. Why does the public reject any earthquake hazard abatement plan if it involves money or effort? This is particularly puzzling when we consider that the same public will expend great funds and efforts for fire safety. We need to understand the psychology of natural disasters to develop a strategy for selling preparedness.

PREDICTIONS

What are the chances of a great earthquake in our lifetime? Figure 3 plots a chart of intensities vs. return periods, based on a 1972 NOAA study. With the last great earthquake having happened in Northern California in 1906, in Southern California in 1857, and in the Sierras in 1897, it would seem that we are all living on borrowed time.

And when the borrowed time runs out, what kind of balloon payment will the people of California have to pay? Jim Davis and the California Division of Mines and Geology prepared Earthquake Planning Scenarios for the Earthquake Preparedness Task Force, for both a Northern and a Southern California event of M8.3. I will not attempt to give a summary of these frightening yet realistic studies. I would like to present just one aspect of the predicted chaos, as seen on Figure 4, which is a graphic representation of a table in USGS Report 81-113. It shows the expectation of casualties and the availability of hospital beds in both the San Francisco Bay Area and the Los Angeles Area. In the Bay Area, for instance, in addition to 11,400 dead, there is a prediction of 44,300 casualties requiring hospitalization. The 9 counties of the Bay Area have 23,000 hospital beds, of which only 10,600 will survive the earthquake. Thus, of the 44,300 needing immediate hospital care, 33,700 will not be able to get it. These 33,700 are likely to die within 24 hours of the earthquake.

SEAOC/ASCE DISASTER PREPAREDNESS

The concept of volunteer participation in disaster crisis management is not new for the engineering profession. Subsequent to the Santa Rosa earthquakes of 1969, the Structural Engineers Association of California and the American Society of Civil Engineers formed a joint advisory committee to help the City Council of Santa Rosa develop guidelines for recovery. The discovery that local government was in no way prepared to cope with such emergencies, awakened a feeling of deep concern among the engineers involved. This concern resulted in the 1970 formation of the first Disaster Preparedness Committee by SEAOC.

In the years which followed, the SEAOC preparedness program flourished. All four associations (San Diego, Los Angeles, San Francisco and Sacramento) developed Disaster Preparedness Committees. Under excellent widespread leadership, about 400 members of the associations registered with the State Office of Emergency Services and received photo-specific indentification cards as volunteer engineers. Orientation meetings were held. A contract between OES and SEAOC was developed to assure volunteer engineers of being held harmless for their disaster work.

The American Society of Civil Engineers joined the preparedness movement in 1980, when the San Francisco Section formed its Disaster Preparedness Committee, to assist with the assessment of dams, bridges, roads, airports, water and sewer systems, and other essential structures and services. Since then, the other California Sections of ASCE have followed this example.

power source, for within the disaster area as well as to outside sources of relief. We needed transportation; helicopters for rescue, STOL aircraft for evacuation out and supplies in. We needed evacuation centers for collecting casualties; we needed personnel to man them. We needed field hospitals with personnel, medicines, equipment and beds. We needed ground transportation. We needed rescue equipment. We needed water. We needed engineers to assess damage, to declare buildings safe or unsafe, to check bridges, dams and sewer systems, and answer questions only engineers could answer.

We were asked where 10,000 dead bodies could be stored so that they would be properly preserved till the coroners could get to them. We were asked whether people living below a dam should be evacuated. We were asked who would be responsible if a building, declared safe by our assessment engineers, collapsed nevertheless.

We found that none of the government agencies was prepared to cope with such a major disaster. Officials of the State Office of Emergency Services, supposed experts in emergency management, were inadequately prepared, by training or by experience, to maintain effective control. Local officials could not cope with a situation when telephones were dead, electric typewriters and copiers did not operate, and even the coke machine was out of commission.

Our own function, as damage assessment engineers, proved to be more complex than anticipated. We discovered that being armed with a calculator and good will was not enough. We needed identification to get into the disaster area, and visible identification to avoid being shot as looters. We needed tools for exploration--measuring tapes, levels, flashlights, hammers. We needed tools for report making--forms, camera, clipboards, posting signs, maps. We needed survival equipment--first aid kits, canteen of water, 2 way radios. We discovered that we had to work in teams, for effectiveness and for our safety. And, most of all, we found that we needed more coordination and more training.

This was the last significant exercise of the Task Force before the funds were terminated.

PROVING GROUND AT COALINGA

On May 2, 1983, the City of Coalinga, California, became the proving ground for earthquake preparedness. When an earthquake of M6.5 hit this town of 7,000 people in an area of 4 square miles, most of the central area and much of the residental area was destroyed. In reduced scale, this became a prototype for the disaster rehearsed at the Simulation Exercise. Fortunately, no one was killed and there were only 198 injured.

The disfunctions predicted by the Simulation scenario did occur. The telephones went instantly dead. All electrical power failed, so that the radio of the City Government did not function. The City had a stand-by generator for power but it happened to be disassembled for repair. There was no possibility of communicating within the City or with the outside world till the California Highway Patrol and the Office of Emergency Services moved in with their microwave radio.

TASK FORCE ON EARTHQUAKE PREPAREDNESS

In December 1980, the Federal Emergency Management Agency and an Ad Hoc Committee of the National Security Council published a study called "An Assessment of the Consequences and Preparations for a Catastrophic California Earthquake." The findings of the study were dire. In response, the Governor of California caused the formation of the Earthquake Task Force, which later became a part of the State Seismic Safety Commission.

The purpose of the Task Force was to bring about better preparedness for a catastrophic earthquake by developing a level of cooperation between governmental functionaries and people of the private sector which will achieve responsible, self-confident and effective behavior by the private sector in case of a catastrophic earthquake.

Within the Task Force, a Damage/Engineering Services Advisory Committee was formed. Its function was defined as a two-fold task:

1) to evaluate, refine and broaden the existing systems in the private sector whereby qualified engineering expertise will be made available following a disastrous earthquake; and
2) to mobilize design and construction professionals into a system of volunteer teams for rapid and effective response to a call by the Office of Emergency Services.

The purpose of the volunteer engineer teams was defined as follows:

1) the primary task of the teams is to assess the safety of occupancy of buildings;
2) a secondary task is to provide initial cost of losses determination to OES;
3) another secondary task is to include professionals in the team who would gather data for long term learning from earthquakes.
4) an incidental but essential task of the teams is to pinpoint locations for rescue teams.

The Task Force functioned for 2 years. It was funded by the State Legislature with less than 10% of the funds requested by the Governor. It mobilized about 400 people from all walks of life. All I can say about the 400 is that they are the best people of the greatest nation on Earth. We did not provide too many answers--it takes funding to provide answers for emergency management. But the Task Force succeeded in exploring the problems so that, today, we finally know the questions that need to be asked. Today the goals are better defined, and some of the paths of achievement mapped.

SIMULATION EXERCISE

In May of 1982, an earthquake simulation exercise was conducted at Los Alamitos Armed Forces Reserve Center. The scenario was an M8.3 event, epicenter San Bernardino, intensities from Mercalli IX to XI. Precomposed messages were sent to the responding posts at the command center.

Very quickly, we learned many lessons in emergency management from this exercise. First, we found that there was need for instant, massive government assistance. We needed a radio communications network, with its own

The trained professionals of the State of California and the volunteer elements of the Task Force responded to the emergency well and fast. The Office of Emergency Services began coordinating emergency efforts within 8 minutes of the earthquake. The American Red Cross opened a Disaster Service Center within 90 minutes. Food and temporary housing was organized by ARC, The Salvation Army and the California National Guard within hours. The Structural Engineers Association had 25 volunteer assessment engineers ready to move within 3 hours.

The breakdown was in the performance of local authority. The City of Coalinga was in no way prepared for such an earthquake. When they called on the County of Fresno for help, the Sheriff of Fresno County usurped the command of the emergency. Constitutionally, local authority should have remained in command or should have handed over command to the Office of Emergency Services; however, all functions were curtailed by the arbitrary decisions of the County Sheriff. The City Manager and the City Fire Chief were prevented from functioning. The assistance offered by the Office of Emergency Services was refused. The Highway Patrol and the National Guard were overruled. The City Building Inspector, in turn, refused the services of the volunteer engineers offered by the Office of Emergency Services. Damage assessment was performed by non-professional County health inspectors who evacuated many people for insufficient reason. The professional structural engineers were not called upon till the 5th day of the event. When they arrived, they were given inadequate directions. No systematic review of damage was ever performed, and some old and handicapped people in damaged buildings were not reached for many days after the damage. The Sheriff also prevented other authorized professionals from entering the damaged area, including those sent in by the State Structural Safety Section, by the State Seismic Safety Commission and by the Governor of the State. Professionals were only permitted to enter the damaged area when accompanied by the Sheriff's armed guards, "to prevent looting." Though the central business area was evacuated, structural engineers were not permitted to study the damage until most of the rubble was cleared away, thus negating the efforts to learn from earthquakes.

An example of the type of chaos that existed is that while the Fire Department prevented fires by the immediate turning off of gas lines all over the City, utility workers proceeded with equal zeal to turn on the gas lines the firemen turned off. The only reason there was no panic and total chaos was because of limited casualities, small area of damage, small population, flat terrain and the disciplined behavior of the people of the City. Had there been more than one city or more than one county involved, the "protection of turf" efforts could have caused chaos.

The response of local authority to the Coalinga earthquake made it clear that the State of California needs to develop its earthquake preparedness to a much greater extent if massive losses are to be prevented in the coming Great Earthquake.

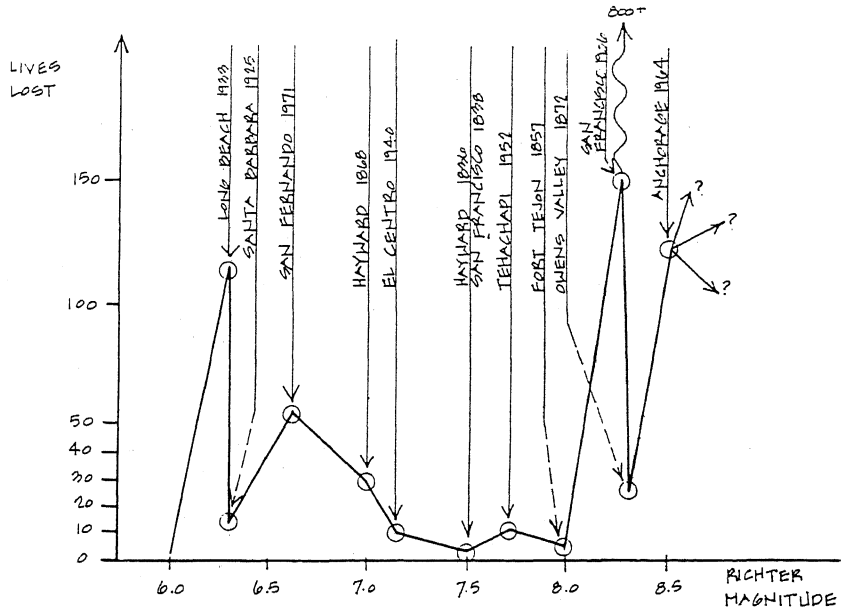
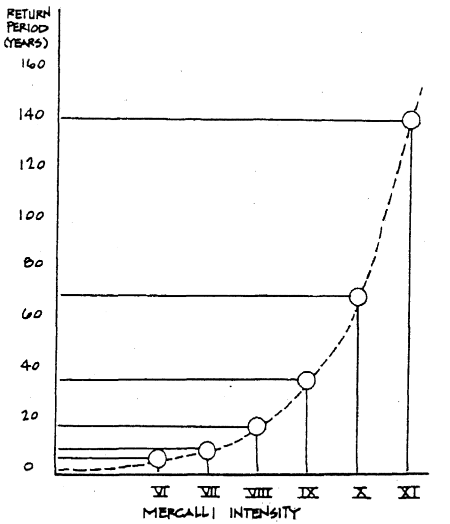
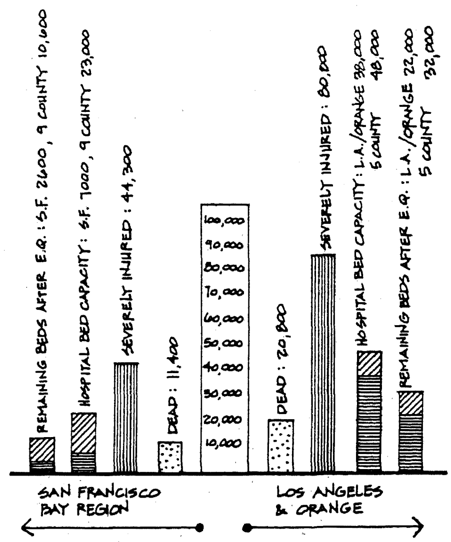


FIGURE ①



NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION 1972 STUDY FOR FEDERAL OFFICE OF EMERGENCY PREPAREDNESS

FIGURE ③



CASUALTY SCENARIO, AT 4:30 P.M., (USGS REPORT 81-113) FOR EARTHQUAKE OF MAGNITUDE 8.3

FIGURE ④

	THE EVENT	SMALL FIRES	MAJOR FIRES	FLOODS	HURRICANES TORNADOES	VOLCANIC ERUPTIONS	AVALANCHES LANDSLIDES	LIGHT EARTHQUAKES	MODERATE EARTHQUAKES	SEVERE EARTHQUAKES	GREAT EARTHQUAKES
BEHAVIOUR PATERN OF DISASTER	APPROXIMATE FREQUENCY OF OCCURENCE	DAILY	ALMOST DAILY	YEARLY	YEARLY	RARELY	YEARLY	WEEKLY	YEARLY	ONCE A DECADE	ONCE A LIFETIME
	FREQUENCY IN DENSELY POPULATED AREAS	OFTEN	RARELY	RARELY	SOMETIME	ALMOST NEVER	RARELY	OFTEN	OFTEN	OFTEN	OFTEN
	KILLING FREQUENCY	OFTEN	OFTEN	OFTEN	OFTEN	SOMETIME	SOMETIME	RARELY	SOMETIME	A KILLER BUT RARE OCCURENCE	BIG KILLER BUT RARE OCCURENCE
	NUMBER OF VICTIMS	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	NEAR ZERO	SMALL	CAN BE HUNDREDS	CAN BE NEAR MILLION
	PROPORTIONALITY BETWEEN SIZE OF EVENT AND NUMBER OF VICTIMS	NO	NO	NO	NO	NO	NO	← EXPONENTIAL RELATIONSHIP →			
THE DISASTER VIEWED BY T.V. AUDIENCE	IS IT SPECTACULAR AND PHOTOGENIC ?	YES	YES	YES	MAYBE	WOW	MAYBE	NO	MAYBE	YES	WOW
	IS IT SOMETHING LIKELY TO HAPPEN TO ME ?	YES	YES	NO	NO	NO	NO	MAYBE	NO	NO	NO
	WHERE DOES IT OCCUR ?	RIGHT HERE	RIGHT HERE	← SOMEWHERE ELSE →							
THE EFFECT OF DISASTERS ON SOCIETY	DOES IT REQUIRE INTERVENTION BY GOVERNMENT SERVICES ?	YES	YES	YES	MAYBE	RARELY	MAYBE	RARELY	MAYBE	YES	INSTANT MAJOR ASSISTANCE
	DOES IT INTERRUPT : THE LIFE OF THE FAMILIES ?	YES	YES	YES	YES	RARELY	MAYBE	RARELY	MAYBE	YES	YES
	THE LIFE OF THE TOWN ?	NO	MAYBE	MAYBE	RARELY	RARELY	MAYBE	RARELY	YES	YES	YES
	THE LIFE OF THE NATION ?	NO	NO	NO	NO	RARELY	NO	NO	NO	NO	CAN BE NATIONAL CATASTROPHY
DISASTERS AND THE PLANNING PROCESS	IS THERE A RETROFIT POTENTIAL OF EXISTING FACILITIES ?	POSSIBLE & FEASIBLE	POSSIBLE & FEASIBLE	POSSIBLE BUT EXPENSIVE	NO	NO	NO	POSSIBLE BUT EXPENSIVE	POSSIBLE BUT EXPENSIVE	POSSIBLE BUT EXPENSIVE	POSSIBLE BUT EXPENSIVE
	DOES THE IDEA OF THE DISASTER GENERATE FEAR ?	GREAT	GREAT	SOME	SOME	NO	NO	NO	SOME	SOME	ALMOST NONE
	DOES THE CONCERN EFFECT LEGISLATIVE BODIES ?	YES	YES	YES	?	NO	?	NO	RARELY	RARELY	ALMOST NEVER
	IS PREVENTION PURSUED ?	YES	YES	SOME : DAMS	NO	NO.	SOME : STUDIES	← NOT POSSIBLE →			
	IS REMEDIAL ACTION DEVELOPED ?	YES	YES	NO	NO	NO	NO	← ALMOST NONE →			

THE PSYCHOLOGY OF NATURAL DISASTERS : FIGURE ②