OBSERVATIONS ON PLANNING FOR REBUILDING IN AREAS OF GROUND FAILURE*

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SUMMARY

The failure of ground raises important land use questions regardless of whether the failure is caused by an earthquake or some other factor. The questions cannot be effectively addressed without adequate geotechnical evaluation which is often not available. This paper describes several ground failure events mainly in terms of how geotechnical information was obtained and used in planning for reuse in areas of failures. The focus is on ground failures which occurred in the communities of Inverness in Marin County and Love Creek in Santa Cruz County, California in January 1982. Several problems in response are noted and solutions suggested.

INTRODUCTION

Ground failure is a broad term covering a variety of phenomena with the common characteristic of altering the surface of the ground. Landslides, debris flows, mudflows, rock avalanches, surface fault rupture, subsidence, settlement, differential settlement are all forms of ground failure. Failure may occur for a variety of natural and man-made reasons. Earthquake shaking and heavy rainfall are two major natural contributors to ground failure.

The failure of ground in any developed area is almost always a land use issue. Typically, the basic question is what use or uses should be permitted in the area which failed. To answer this question, it is almost always necessary to know what caused the failure, whether or not additional areas are threatened, and the potential for additional movement of the failed area. Without the answer to these questions, reasonable decisions about the future uses of failed lands cannot be made. Unfortunately, history shows that land use decisions in areas of ground failure often are not reasonable in the sense that opportunities to reduce future risk are not taken.

PREVIOUSLY STUDIED GROUND FAILURES

In previous studies of planning for rebuilding after earthquakes, it was clear that many of the more difficult problems -- those that took the longest to resolve and engendered the most controversy -- involved areas where ground failures occurred (Ref. 1).

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This paper is based on research in process supported by the National Science Foundation under Grant CEE 8209252. However, any opinions, findings, conclusions or recommendations are those of the author and do not necessarily reflect those of the Foundation.

Anchorage, Alaska, 1964

The most obvious examples are the landslides that occurred in Anchorage during the 1964 earthquake. Almost 20 years later, controversy still surrounds land use questions in the slide areas of L Street and Turnagain Heights. In both areas, rebuilding has occurred with no demonstration that the areas have stabilized. The risk of future damage and loss of life is high and efforts to reduce it are complicated by the decisions made after the 1964 earthquake.

In the L Street area, the decision to rebuild on a slide mass declared unstable by the Corps of Engineers was made very soon after the earthquake. The area was rezoned to permit a higher density development than permitted before the earthquake. In other words, the reconstruction after the earthquake was viewed as an opportunity to achieve renewal and revitalization of the downtown area -- risk was not a large factor in the decisions. To the extent that risk was reduced -- as in the 4th Street slide in Anchorage -- it was done in direct response to Federal requirements backed up by funding.

Turnagain was pretty well ignored in the immediate aftermath of the quake. The general feeling seemed to be that no one would ever be foolish enough to want to build there again. Geotechnical study concluded that the slide mass would remain unstable unless erosion of the slide mass along Knik Arm was controlled. No erosion control has been instituted and years after the earthquake the Anchorage Municipal Assembly is still grappling with questions regarding utility extensions into the slide mass to permit rebuilding on the lots. A major error in this case was the failure of a public agency to acquire title to the parcels destroyed at Turnagain. As part of disaster assistance, the property owners were given lots in another Anchorage subdivision -- Zodiak Manor -- and also allowed to retain title to their Turnagain parcels. A fact that is now haunting the City.

San Fernando, California, 1971

Responding to areas of ground failure was also a major concern following the 1971 San Fernando earthquake. In this case, decisions about rebuilding Juvenile Hall and Olive View Hospital were particularly knotty. The contribution of ground failure to the damage was not as clear cut as in the Anchorage cases. Liquefaction was suspected as a factor and both structures were critical, high-occupancy facilities which added urgency to the issue. In both cases, extensive geotechnical work was done prior to decisions regarding rebuilding. Both facilities were rebuilt on the original sites but not until evaluation of alternative sites was carried out. Sites and buildings were engineered to reduce seismic vulnerability. The new Olive View Hospital was finally under construction in 1978, seven years after the earthquake.

Bluebird Canyon, 1978

The Bluebird Canyon landslide in Laguna Beach, California in 1978 is an analagous situation. Here the slide, which destroyed twenty-four homes, was not caused by an earthquake. The area was eligible for federal disaster assistance under a declaration for storm damage the previous winter. The heavy winter rains were an apparent cause of the failure.

The Bluebird Canyon slide was stabilized, resubdivided and reconstructed amid much controversy between the Federal Disaster Assistance Administration (FDAA), the forerunner to FEMA and the local people over the distinction between emergency and permanent stabilization. FDAA regulations permitted funding for emergency stabilization, i.e. that required to prevent further failure and damage to public property, but not for permanent stabilization. This issue was largely semantic since, in fact, achieving emergency stabilization resulted in permanent stabilization. The concentration on a non-issue resulted in a failure to address the real question of replanning the use of the area. This question was settled by the affected property owners without specific decision by the public agencies involved.

GROUND FAILURES, 1982

In January 1982, an extremely wet winter season in Northern California culminated with a series of storms which triggered numerous ground failures throughout the area. Many of the failures were of surficial material variously termed mudflows, debris flows, debris slides, and debris avalanches. However, some deep landsliding also took place. These ground failures were seen as surrogates for earthquake-induced ground failures in terms of the response needs. In order to learn from this experience anything that would be applicable to improving response to earthquakes the National Science Foundation funded a study, Planning and Engineering Response to Landslides (PERL (Ref. 2). The study is being conducted by an interdisciplinary team composed of planners from William Spangle and Associates, Inc., and engineering geologists from William Cotton and Associates.

The focus is on response to the Love Creek landslide in Santa Cruz County which killed twelve people and destroyed nine houses, and the debris flows and flooding in Inverness in Marin County, California which destroyed houses and altered drainage basins in this small community on Tomales Bay. These events are being examined to determine common response needs and problems. The objective is to develop recommendations to improve disaster response especially with respect to rebuilding decisions in areas affected by ground failures.

The incidents also provided an opportunity to observe the effectiveness of new Federal Emergency Management Agency (FEMA) procedures pertaining to hazard mitigation. The FEMA procedures authorized by Section 406 of the Federal Disaster Relief Act of 1974 were given substance through a series of regulations adopted in the late 1970's requiring a specific hazard mitigation planning process. The storms in January 1981 provided one of the early laboratories for implementing the 406 regulations as well as related regulations pertaining to response to flooding.

Love Creek, Santa Cruz County

The Love Creek landslide in Santa Cruz County is one of the largest landslides ever to occur in North America. More than two million cubic yards of earth, rock and debris moved downslope burying people and houses. This was one of few block landslides to occur in the wake of the January 1981 storms; most of the failures were debris flows or mudslides involving only surficial material. The slide occurred in a narrow, steep sided valley on a

dip slope. Debris flows occurred on either side of the block slide and debris and earth created a dam in Love Creek forming a small lake.

Initial geotechnical evaluation was carried out by volunteers from nearby areas. Preliminary assessment revealed cracks in an area adjacent to the slide headscarp foreboding the possibility of additional large-scale ground failure. Orders were given by Santa Cruz County to evacuate houses downslope of the incipient slide area.

Santa Cruz County is one of California's smallest and poorest counties. Proposition 13 has cut deeply into its financial base, necessitating cutbacks in County staff and programs. The County's population is overbalanced with retired people and students. Development controls have never been strong or strongly enforced and the Santa Cruz Mountains are dotted with cabins and self-built homes constructed without building permits and often with inadequate information about the natural characteristics of the site.

Slope stability mapping from aerial photography had been done by the California Division of Mines and Geology for much of the mountain area, but the maps had not yet been used as the basis for regulation or planning. Because the mountains are densely forested, landslide areas are difficult to identify from aerial photographs. The maps probably understated the landslide hazard.

The County does have a staff geologist -- a geology professor at the University of California at Santa Cruz who reviewed geotechnical reports and advised the Board of Supervisors on matters pertaining to geologic hazards. Another staff member serving as head of the Environmental Planning Department also has a geology degree. These people with volunteer assistance from consulting engineering geologists from Santa Cruz and Santa Clara counties made the major recommendations regarding the response to the Love Creek slide to the Board of Supervisors.

The major questions were clear within a few days of the landslide. What should be done about the slide area and what should be done about the potential slide area. Neither could be effectively answered without fairly detailed geotechnical evaluation. As it happened, no one wanted to pay for the necessary work. After much controversy, FEMA contracted with the Corps of Engineers to undertake a study of the potential slide area. No subsurface work was involved. The study concluded somewhat tentatively that the area was unstable.

The Board of Supervisors subsequently "abated" the homes on or below the potential slide. This meant that the homes could not be legally occupied and would have to be demolished. Because no damage had occurred in the area, the residents were not eligible for any disaster assistance until the abatement order had been adopted, even though they had effectively lost use of their homes since the slide. The abatement order was challenged and enforcement delayed for a year. Additional failure did not occur during the winter of 1982. The best guess is that the abatement order will be rescinded and people will move back in or sell their property to other people who will move in. Failing formal rescinding of the order, it is likely the County will look the other way while people gradually reoccupy the site.

In the meantime, the question of what to do about the slide mass itself remains unaddressed. Like the Turnagain case, there appears to be an assumption that no one would want to build there again with the bodies and houses still buried at the base of the slide. No funds are available for purchase of these much altered lots. And nothing has been done to evaluate the prospects for future natural or created stability of the slide mass.

Inverness, Marin County

Debris slides in the steep valleys along Inverness ridge damaged houses, utilities, roads both directly and through flooding caused by stream channel blockage and resulting overflow. No one was killed in the slides and flooding in Inverness and few houses were totally destroyed. However, many houses suffered damage either from the debris or from flooding. Like the Love Creek area, Inverness is a small unincorporated coastal community with some seasonal and some permanent residents. Much of the community was subdivided in the early 1900's with little regard for topography or other natural features.

Inverness was isolated from outside help for about 48 hours after the storm and no geotechnical assistance was forthcoming until about two weeks after the storm. The engineering firm of Leighton & Associates was contacted by the owner of a damaged home in Inverness. Two engineering geologists from the firm joined with a local group called PRIOR -- Point Reyes-Inverness Organization for Reconstruction -- formed by local contractors and interested citizens after the slides/floods to assist residents in evaluating their damage. The intent was to marshal local expertise on a volunteer basis. An ad offering help was placed in the Point Reyes Light and over 85 people called for assistance.

A file of requests was established and a form drafted to record information. Contractors then visited each household that requested help and made a preliminary diagnosis of the problem and especially of the kind of follow-up-expertise needed. About 20 minutes were spent with each household; polaroid pictures were taken and attached to the forms illustrating the problem. Then with the engineering geologists, PRIOR worked out a system for coding the geotechnical problems and the level of hazard. The codes indicated the nature of the problems and the degree of risk. The information was recorded on a map in colors: red for emergency situation requiring immediate attention, yellow for cautionary situation and green for minimal hazard. Over 60 situations were evaluated, coded and mapped. All the work was done on a volunteer basis and no funding was received from outside agencies to cover the cost of the professional work.

The assessment was preliminary and left many people with problems identified but no place to turn for solution. In addition, the County needed help assessing damage to public property.

Marin County hired Woodward-Clyde Consultants to conduct a technical evaluation of damage and damage mitigation measures focusing on flood damage to public facilities -- especially streets. The results helped the County complete the paperwork required by FEMA as a basis for 75% funding for repairs to public facilities. The study, completed in May 1982, dealt largely with the hydrologic problems and provided a check list of potential

mitigation measures. This list and supporting information was used as background in revising the Community Plan in the summer of 1983.

Major issues were the reconstruction of the stream corridors which were severely damaged by debris and flooding. Debris was a major problem and the community faced the winter 1982-83 season with very inadequately cleared channels and a patched-up and vulnerable water supply and distribution system. Fortunately, heavy rains did not severely impact the Inverness watershed in the winter of 1982-83. Clean up of the channels is still proceeding.

PROBLEMS OBSERVED

The most obvious and pervasive problem in responding to ground failure events appears to be the lack of explicit procedures, authority and funding to obtain the geotechnical information needed to properly evaluate immediate threats of additional failure or to decide future uses in areas of ground failure. The federal government has instituted procedures requiring evaluation and mitigation of hazards as a condition for federal disaster assistance. However, no provision is made for acquiring the basic information to adequately evaluate ground failure hazards. States are requested to prepare Hazard Mitigation Plans following a Presidential disaster declaration, but do not presently have procedures to acquire the information needed or to directly implement plan recommendations. Local jurisdictions make the key decisions, yet often lack the experience, expertise, political will and resources to address hazard mitigation in recovery from landslide disasters. Geotechnical professionals who offer assistance, sometimes as volunteers, to communities in the aftermath of ground failure incidents are exposed to liability.

The core of this problem is the question of who is responsible for the cost of obtaining the information and repairing the damage. The federal government, the state, local government and private owners all have some role, but the boundaries aren't clear and for the most part, each is operating to minimize its costs.

Other problems related to ground failures include 1) inadequate consideration of permanent relocation of businesses and residents as a means of reducing future risks; 2) failure to ask directly the key land-use question "What permanent use or uses should be permitted in the slide area, and under what conditions?"; 3) lack of explicit requirements or motivation for replanning; and 4) confusion over both public and private liability for taking and not taking actions.

POSSIBLE SOLUTIONS

Possible solutions to some of the problems include: 1) explicit authority for FEMA and/or state agencies to fund geotechnical studies of ground failure areas to provide the data needed to make decisions regarding future uses, 2) increased role by the geotechnical professional organizations in training and mobilizing professionals for post-disaster geologic investigations to provide information needed for reconstruction planning, 3) reevaluation of liability provisions in state law as they pertain to

professional services offered in the aftermath of a disaster, 4) procedures and funding for property acquisition and relocation of businesses, residents, 5) specific requirements and procedures for planning for reuse of slide areas as a condition of public disaster relief funding, and 6) increased state role in assisting local jurisdictions to plan for reuse of slide-affected areas. These and other possibilities are being evaluated . The results should be directly applicable to pre- and post-earthquake planning in the United States.

REFERENCES

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