SOME DEVELOPMENTS IN STATE AND FEDERAL EARTHQUAKE HAZARD REDUCTION PROGRAMS

By

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Major Problem Areas

The long-standing American tradition of local control over building construction has been expressed through local building codes, and these codes now include provisions for earthquake bracing of new construction located in many earthquake hazard regions. The technical provisions and the philosophies involved are adequately covered by other papers presented at this conference, and need not be repeated here. This paper, then, will give emphasis to the major unresolved earthquake hazard problems, and the growing non-local governmental concern over these and related problems.

It is of value at this international conference to very briefly review the history and present status of the earthquake provisions of local building codes in order to obtain a better perspective of the reasons and objectives for the growth of interest in programs at State and Federal levels.

The great earthquake disaster which struck San Francisco, California in 1906 had many lasting impacts, but surprisingly it had not more than short-lived influence on building codes. Substantial renewed interest was shown in the problems relating to earthquake hazards after the Santa Barbara, California earthquake of 1925, but this interest also had minimal impact on effective hazard reduction programs. The Long Beach, California earthquake of 1933, which lead to 102 lives lost and which destroyed many buildings in a number of cities including Long Beach, resulted in strong local building ordinances throughout the metropolitan Los Angeles area. In addition, a California state law was passed at that time which required that all <u>new</u> public schools be designed and constructed to be highly earthquake resistive. This State of California law, commonly known as the Field Act, has over the years proven to be very successful.

As strange as it might seem, it wasn't until about 1950 that most of the cities within the metropolitan San Francisco area were willing to acknowledge the peril of earthquakes by including provisions in their local building ordinances. Since 1950, earthquake bracing requirements within building codes have become commonplace for most communities in the western part of the United States.

Major Unresolved Public Policy Areas

From the foregoing brief history, it is clear that most building construction still in existence in California and in other states was built prior to the enactment of earthquake bracing laws. Many of these older buildings are hazardous in the event of a great earthquake. The major life loss in a great earthquake undoubtedly will result from the collapse of non-earthquake resistive construction which includes dams as well as buildings.

The City of Los Angeles has had a program to reduce the most serious of the hazards relating to these older buildings, namely the removal or bracing of hazardous parapets and appendages. Other California cities are giving thought to taking some sort of action, but basically the overall problem of hazardous older structures remains unsolved by local government.

Thus, the first and possibly foremost problem requiring public policy attention is:

Viable programs must be developed to substantially reduce the earthquake hazard of older non-earthquake resistive, collapse hazard structures of all types, including dams.

Present building codes, particularly in the United States, have given little or no direct attention to the problems of earthquake geological hazards. For an extreme case, virtually no local building code specifically restricts the construction of a major structure, such as a hospital, on the trace of a major known active fault. The reasons for this are manyfold, with not the least of these being the lack of adequate criteria for use by local building officials to develop and implement adequate code provisions.

Thus, the second major problem requiring public policy attention is:

Integrated geologic, land use, and engineering criteria must be developed on a practical basis, and these criteria must be implemented through viable programs.

Extensive research, both pure and applied, is being conducted on buildings and on other structures, on construction materials, on soils, in geology, and on many other subjects. The existing directions of public policy is favorable towards research and other studies leading to earthquake hazard reduction. The vast majority of the support for this public policy is at Federal and State levels, and not at local levels. The need in this subject area is not for a new public policy, but is:

Substantially increased support is necessary for integrated research programs, both pure and applied, leading to earthquake hazard reduction.

State and Regional Interest

The foregoing discussion of major public policy problems shows that several subject areas must receive additional attention. For various adequate reasons, local government has been unable to adequately solve these problems. Not the least of these reasons is the financial implications of implementing adequate policies. Quite understandably, then, State and Federal government has turned its attention to these topics.

The State of California has shown more interest in solving earthquake related problems than have other states and thus this discussion will briefly turn its attention to California.

The first unified attack on these problems in recent years was the Geologic Hazards Advisory Committees for Program and Organization which was established by the Resources Agency of California. The report of these committees, issued in April of 1967, was entitled "Earthquake and Geologic Hazards in California".

A second impetus given to the establishment of State programs was the publication "Earthquake Hazard in the San Francisco Bay Area; A Continuing Problem in Public Policy" which was published by the Institute of Governmental Studies at the University of California. The solutions indicated for the San Francisco Bay Area demanded something greater from a governmental attention standpoint than that being provided by the many local jurisdictions, and a regional governmental approach seemed one possible alternate to State involvement.

With the foregoing background, it may be readily understood why the California Legislature over a year ago established its Joint Committee on Seismic Safety. This committee has been a major undertaking involving over 70 persons who donate their time towards giving advice and guidance to this legislative committee. These advisers are all experts in their own fields which include many disciplines: architecture, structural engineering, geology, soils engineering, city planning, insurance, banking, among others.

The San Fernando, California earthquake of 1971 placed special emphasis on the need for quick action to remedy some of the most serious earthquake hazards which became obvious from this earthquake. A number of bills were introduced into the State Legislature, with some topics being as follows:

1. Hospitals

The excessive damage which occurred to the newly completed earthquake resistive Olive View Hospital came as a shock to structural engineers and architects as well as to the public. Three other hospitals also were severely damaged; of these, two were earthquake resistive. Hospitals are a special class of structures which, after a disaster such as an earthquake, are in greater need after the event than before the event. At present, efforts are being made to place hospitals under a type of state control similar to that of the Field Act which regulates public school construction.

2. Strong Motion Seismic Instrumentation

Legislation is being considered which will help to satisfy the serious need for much greater information regarding the strength and other engineering characteristics of earthquakes. The opportunities to record a major earthquake in the epicentral region are rare, and no opportunity must be lost. Thus, the Joint Seismic Safety Committee is considering legislation which will, in effect, greatly increase the network of strong motion instruments throughout the State of California.

3. Dwelling Construction in Fault Zones

Construction in earthquake active fault zones requires far greater attention than has been given to it by building codes. To the author's knowledge, there are no effective building ordinances at any level of government which adequately control structures in and about a fault zone. Therefore, legislation is under study which is intended to reduce this particular hazard.

Other legislation is being proposed and some of it is of equal importance. All of this legislation is showing a growing awareness of earthquake hazards and the need for a more centralized governmental approach to adequately solve these problems. It is anticipated that State government involvement will continue to grow where local governments appear to be inadequate.

Federal Interest

The United States Federal government has increasingly supported earthquake engineering research, but many feel that the increase must be accelerated. This research has been principally through the National Science Foundation and the United States Coast and Geodetic Survey (now the National Oceanic and Atmospheric Administration). In addition, in recent years the United States Geological Survey has become interested in some earthquake engineering problems along with its considerable interest in earthquake geologic hazards.

However, there has been no overall unified Federal approach to pure and applied programs relating to earthquake hazard reduction. This deficiency, among others, has been noted and commented on in a number of reports to the Federal government. Major reports were made in 1965, 1968 and 1969. As a partial result of the foregoing, a Task Force on Earthquake Hazard Reduction was appointed by the Executive Office of the President through its Office of Science and Technology. The author of this paper had the privilege of being chairman of this Task Force.

It is not the purpose here to review in detail the recommendations which were given in the Task Force report. However, it is quite appropriate to briefly summarize what needs to be done. The following has been liberally quoted from "In the Interests of Earthquake Safety", authored by the members of the Presidential Task Force, and published by the Institute of Governmental Studies at the University of California at Berkeley.

1. Priority Programs for Federal Support

Some priority programs of earthquake hazard reduction are highly urgent, offer opportunities for substantial early benefits with little cost, and are particularly suitable for Federal encouragement and support. These include establishing and enforcing Federal standards requiring earthquake resistant design and construction of important publicly owned facilities, and of privately owned facilities built with direct or indirect Federal help. A Federal agency should also enforce adequate standards during the reconstruction period following a major earthquake. The Federal government should accelerate work on the mapping of earthquake geologic hazards in metropolitan areas, vigorously encourage strong-motion earthquake research, and conduct full-scale tests of structures at the Nevada atomic test site. The Federal government should help communities evaluate their rôles in hazard reduction, and take responsibility for a realistic overall plan for earthquake disaster response.

2. Some Governmental Tools for Hazard Reduction

Achieving the goals of all the other programs will depend on effective implementation and enforcement. Thus it will probably be necessary to devise some new governmental machinery for regulation and land use control. Financial incentives are needed to encourage high standards of design, and penalties can help discourage poor performance.

3. Urban Planning for Seismic Safety

Imaginative and prudent planning for urban land use and for public facilities can abate existing hazards and reduce those posed by future development. To be effective, good basic planning must be backed by appropriate governmental tools for implementation and enforcement.

4. Strengthening Basic and Applied Research

Intensified research efforts are needed on earthquake cause, frequency, and distribution. Geodetic research is needed to determine more accurately the distortions in the earth's crust that precede, accompany and follow major earthquakes. Research in engineering and design must be augmented substantially in furthering a basic objective: the development of better and safer structures that can withstand foreseeable future shocks.

Time and space do not allow a more detailed review of the apparent directions being taken by public policy in State and Federal earthquake hazard reduction programs. But, clearly, State and Federal involvement is expected to grow substantially in these programs, and quite possibly it may pre-empt local government where it has inadequately solved the problems.

TYPES OF CONSTRUCTION AND SPECIAL BUILDING STANDARDS

Eng. Ferlito and Eng. Cipollini

The memoranda will deal with the following aspects: provisions adopted in Italy with a view to regulating building activity in the Municipalities subject to intense seismic movements by dividing said Municipalities, or sections of them, into categories, in relation to the extent of seismicity and geological composition.

The information criteria of the new seismic law, and in general, the prevention aspect of earthquakes effects with suitable technical standards, which concern new constructions as well as repairs, rebuildings and elevations in the old built-up centers.

Investigations to determine the interventions necessary for reducing the dangerous character of the earthquakes in the centres made up mainly by old buildings.

Furthermore, engineer Cipollini will outline the following subjects: national seismic network (selection of stations and utilization of data); experiences of the effects of recent earthquakes on mural or reinforced concrete constructions. scientific research underway on seismic engineering.

"SEISMIC MAPS"

Dr. Peronaci

Within this year a seismotectonic map will be completed listing all earthquakes of the past two centuries. The map will consist of a number of tables, and has been worked out taking into account two fundamental principles:

(1) to place the seismic activity in relation with the geotectonic characteristics of the national territory in keeping with the recommendations and criteria agreed upon within the U.G.G.I. (Position of the focus with regard to the active faults, magnitude, intensity);

(2) to determine the maximum permissible intensity for each region and the wave frequencies so as to provide additional data to the problem of constructions in seismic zones.

In view of the striking geological and tectonic complexity of the Italian Peninsula, the elaboration is effected by breaking down the territories into 12 regions for each of which different formulas of correlation between magnitude, frequency and intensity had to be worked out.

This map is the first step towards reaching subsequent enlargements up to 500,000 and 250,000 for those zones featuring a high seismicity that will have to be more closely studied with microregionalization criteria.

PREVENTION OF EARTHQUAKES - RESULTING DISASTERS AND TECHNIQUES FOR DANGER REDUCTION

Dr. Peronaci

Reference is made to the program that has been under way for several years at the National Institute of Geophysics jointly with the Ministry of Public Works so as to reach more valid and modern standards for constructions in zones featuring high seismicity.

The program entails:

- a microseismic study of similar origin earthquakes, by using recordings of the natural network, as well as those of mobile stations which come into action in case of seismic events;
- a study of the behavior of active faults (accelerometer and clinometer stations);
- surveys on the coefficients of energy absorption and on the prevailing periods;
- determination of response and acceleration spectra by resorting to data obtained by the accelerometer network of the Ministry of Public Works now being set up. To this end, several recordings have already been obtained and the relative spectra have been calculated.

Lastly, mention is made of the criteria followed by the Commission of the Superior Council of Public Works aimed at reaching new standards which are to replace the conventional static force with the dynamic action of earthquakes on the building.

PLANNING AND ZONING FOR SEISMIC HAZARDS

A GENERAL PROPOSAL

by

E. Jack Schoop, AIP

In the past, planning for our cities has taken little note of ground conditions that might prove to be hazardous in the event of an earthquake. Geologists who were aware of such hazards and urban planners who plotted the future development of cities were virtually unaware of each other. The situation has only begun to change in the years following the 1964 great Alaskan earthquake when, for the first time, very large sums of money were expended for research into the causes of the extensive disaster. Thereafter, increasing attention has been focussed on the fact that geology, as well as building codes, needs to be considered in reducing the hazards from earthquakes. For, we have learned that even the most solidly constructed building cannot stand on ground that fails beneath it.

The role of planning and zoning in the United States

A note about planning and zoning in the United States. Here, urban plans are of an advisory nature even though they may be officially adopted by the city or county government under whose auspices the plan was prepared. American city plans are indirectly implemented by a variety of development programs and regulations; the foremost regulatory instrument is the zoning ordinance which, when adopted by the city or county, has the force of law in regulating what an owner may do with his property. Other means of implementing the plan are municipal action in redevelopment programs, and provision of public utilities, road and schools. It should be further observed, that political pressures and other circumstances will frequently cause a city to be developed in a manner different from that anticipated in its urban plans.

Urban planning for earthquake hazards

In the aftermath of the Alaskan earthquake, it was realized that we have painfully little scientific information about what happens to the ground during the violent shaking of an earthquake but also that we could substantially reduce future hazard by applying what we do know now.

We already know a fair amount about fault zones, unstable soils, and the behavior of steep slopes. Geologists can chart where these phenomena occur within the urban region. However, they cannot be categoric about the degree of hazard that might be involved because, of course, engineering solutions may be devised to satisfactorily overcome the hazard.

The land planner, working with the geologist, should consider the potentially hazardous areas as one of the numerous parameters of his planning. Together with engineers, they should identify areas for which some degree of seismic hazard can be anticipated and indicate what general precautions ought to be taken in view of the extent of hazard indicated. The findings and mapping will usually have to be fairly generalized because detailed exploration of all of the ground will seldom be feasible.

The planner, in making his plans, can then seek to avoid intensive urban development or the location of critical public facilities in areas where there is a fairly sure indication of major hazard that probably cannot be offset by engineering. In other hazard areas that have been indicated, he can note that the potential hazard exists and that special engineering should be considered for any development proposed in such areas.

A major consideration is the fact that our knowledge of potential seismic hazards is still fairly dim. For instance, it appears that the recent San Fernando earthquake in Southern California was caused by a vertical fault movement instead of the horizontal one that had typified most documented earthquakes in California; the resulting disturbance to the ground was very widespread, but apparently it is not very predictable. This may represent a kind of earthquake hazard which we might not be able to plan against; or, it might represent a new dimension that we should incorporate into our planning. In addition, the generalized concepts incorporated in the plan on the basis of the relatively sketchy information then available will be amplified over time by the engineering studies being done for construction in these areas, permitting a more definitive definition of hazard in future years. Therefore, the urban planner and the geologist should be in constant communication to monitor and implement the new knowledge that is rapidly forthcoming and that will continue to evolve over the coming decades. The urban planner's plan must be revised periodically to incorporate the results of the latest research and experience.

The next Step: Zoning

The typical American zoning ordinance stands by itself and does not make specific reference to the general plan that is supposed to be its foundation. The zoning ordinance consists of regulatory text defining uses that may be allowed in certain types of zones; the zoning map, which is part of the ordinance, divides the city or county into the several zones established by the ordinance.

The zoning ordinance could incorporate the findings and recommendations of the general plan concerning seismic hazard in several ways: (1) the different hazard areas mapped in a general plan could be incorporated on the zoning map as an "overlay" zone that would impose additional regulation beyond that already propounded for the basic zoning that it overlays, (2) if they are relatively few in number, the several hazard classifications could be incorporated with actual use zones (e.g., there might be separate "single family" zoning classifications for hazardous areas and for non-hazardous areas), and (3) geologic and engineering investigations might be uniformly required as a general condition throughout the city or county, eliminating the need for specific mapping of hazard areas. The choice of how recognition of the zoning hazard is incorporated into the zoning ordinance depends to some extent upon what is legally allowable ordinance construction and how varied the hazard might be throughout the city or county. For instance, if the whole city were in essentially the same hazard zone, a general investigation requirement in the text of the ordinance might well be sufficient, whereas in any area where there are a fair variety of distinct categories of hazard, the overlay zone would be most desirable.

What the zoning ordinance should require

As previously noted, the identification of potential seismic hazard is usually tentative pending more detailed engineering investigation or a particular site for a particular development. Since the zoning ordinance regulates the specific uses of the property, it should call for a competent soils engineering report for any development project proposed in an indentified hazard area. Depending upon the sophistication of the preliminary data about the hazard zone, the ordinance should specify an extent of engineering investigation that is appropriate to both the nature of the risk and the nature of the proposed use. For example, engineering requirements for uses involving large numbers of people should be much greater than for very low density uses such as a park or a warehouse area.

A major consideration, given the paucity of knowledge at this time and the varying degrees to which different engineers and geologists have acquainted themselves with it, plus their inherently different capabilities, is the quality of the city's or county's review of the engineering report for a particular development. In addition to continuing evolution of knowledge, a large degree of judgement is required in making recommendations for construction in hazard areas. Furthermore, it has been indicated that a number of different disciplines actually need to be involved in preparing and evaluating a report that is as competent as current knowledge can make it. The knowledge of geologists, soils engineers, engineering geologists, and structural engineers usually needs to be combined.

Therefore, it is recommended that the city or county create an inter-disciplinary board which can include these diverse talents. The board should develop criteria for the guidance of the engineers who will submit reports to them. In practice, because of the subjective nature of the individual problems, preliminary conferences with the project engineer are desirable to work out an understanding of the kinds of studies that should be undertaken for a specific project. The use of the board will not only raise new levels of confidence of the studies for each project but also will eliminate one frequent current frustration for the public official - the contradictory reports of several consultants - particularly if the board is composed of some of the most competent professionals in the city or region.

Given the relative shortage of talent in the field related to seismic hazard, a single board for a whole region or for a substantial parts of a region might well prove to be desirable, particularly if the nature of the seismic problems is fairly thinly spread among the cities and counties in the region. The working model for the board which I have described here is the Engineering Criteria Review Board which is performing the afore-described functions for my employer, the San Francisco Bay Conservation and Development Commission. It is composed of some of the most eminent professionals in the several fields in this country, many of whom are participating in this conference with you.

The final requirement on the zoning ordinance would be that any project that is approved be, in fact, constructed according to the recommendations of the board. For this purpose, competent inspectors will be necessary. Here again, a regional approach might be necessary both in order to lower the cost to the local government and to share the available talent as widely as possible.

Conclusion

The presumption of this paper is that hazard from earthquakes is to a large degree one that can be avoided. It also recognizes that knowledge about what constitutes seismic hazards is still relatively sketchy and general, but is nevertheless sufficient to enable us to avoid substantial future hazards. It proposes that the general hazard be recognzed in the urban planning process and that specific site investigation be required by municipalities under the auspices of an interdisciplinary board of competent professionals concerned with seismic hazard.

It is recognized that the proposed recognition of seismic hazard in future construction does not attack the substantial problem of existing urban development that we must now suspect to be dangerously hazardous in the event of a major earthquake. But, adequate recognition of seismic hazard in the future development is a first step necessary to create the understanding, support, and methodology for eventually dealing with the total problem.

PLANNING AND ZONING FOR SEISMIC HAZARDS

A SPECIFIC APPLICATION, PORTOLA VALLEY, CALIFORNIA

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The experiences of the Town of Portola Valley, California, illustrate one community's attempt to recognize seismic problems in its planning program. Portola Valley, a small residential community approximately 30 miles south of San Francisco, lies astride the well known San Andreas Fault. (Slide 1 - Aerial Photo of Portola Valley with San Andreas Fault shown.) The town covers approximately 10 square miles. Horizontal movement along this portion of the fault at the time of the 1906 San Francisco earthquake was about 6-8 feet. To the west of the fault, steep slopes rise 1600 feet to the crest of the coast range and to the east, less precipitous rolling hills rise 400 feet.

The general plan of the town, adopted in 1965, recommended a growth pattern for the next 20 to 25 years. (Slide 2 - Portola Valley General Plan). The plan calls for low-density residential development of approximately 2 acres per home site, with homes clustered on ridges and retaining the steep canyons as open space. When the plan was prepared, these steep canyons were judged too unstable and fragile for development. It should be remembered, the general plan is used in this country as a general policy guide and is not meant to be specific or detailed. When the plan was prepared, geologic information regarding the San Andreas Fault was not available in a form usable by the planners. Consequently, a situation not uncommon was found wherein rather high intensity uses were proposed along a fault. The plan did, however, propose steep canyons as open space which later proved to have unstable ground.

Three years later, the Town prepared and adopted regulations stipulating the uses that land could be put to and describing methods of subdivision and development. These regulations were the zoning ordinance, subdivision ordinance and grading ordinance. Through the efforts of keenly interested geologists living in the town and a specially created geologic hazards committee, these regulations included a number of provisions requiring geologic studies as a prerequisite to development of land. In general, these regulations require any developer to prepare detailed soils and geologic reports prior to approval of his plans. The developer is required to show how his plan conforms to the soils and geologic conditions and how he plans to solve potential problems which can be corrected.

Concurrent with the adoption of these ordinances, the town retained a town geologist. His job is severalfold and includes preparation of a geologic map of the town, advice to the town on the maintenance of a good geologic program, and finally, and perhaps most importantly, review of all proposed developments and attendant soils and geologic reports. The town geologist reports his recommendations to the town planning commission and town council which rely heavily on his expert advice.

Let us now review a proposed development on approximately 400 acres of land which came before the town recently. (Slide 3 - Aerial photo of Bovet Property). This property had long been thought to be one of the better pieces of land for development in the town due to its gently rolling topography, fine stands of oak trees, access to roads and proximity to an elementary school. The owner had thought for many years that this land would support a fine residential development with large lots distributed rather uniformly over the entire property. The town general plan set forth certain developmental policy for the property. (Slide 4 - Portion of Town General Plan for the Bovet property). The plan proposed a residential density of approximately 2 acres per dwelling unit, greenways along major roads and through a narrow valley, steep wooded hillsides preserved as open space and a clustering of residential development on the remaining areas. The plan is general in that the proposed use areas are not precisely defined and can only be defined through more precise planning as required by the zoning and subdivision regulations. The zoning and subdivision regulations set forth detailed requirements for soils and geologic reports, the design of the street system, the minimum sizes of lots, provision of utilities and many other development considerations.

The developer undertook the required soils and geologic studies at an early date as he thought these would be crucial in the design of the development. His geologist prepared two maps, one showing the geology of the land, the other the relative stability of the different geologic formations. These maps proved a revelation to the property owner and described serious limitations to the development of the land which he had not anticipated. At this stage of the planning process, geologic investigations were based on surface explorations with more detailed geologic work to be done at later stages in the planning and development process.

The geology map showed the eastern portion of the property to consist of relatively stable formations - Butano Sandstone and Franciscan - and areas with relatively thin coverings of slope wash. (Slide 5 - Geology Map). It was thought problems in this area could be handled through proper engineering design. The western portion of the property, however, included a large area covered by landslide debris and many landslide scarps. The map also identified three fault strands, one of which moved in 1906 and was deemed an active fault. This map was translated into a relative stability map, a map which was more meaningful to the engineers and architects designing the development and to town officials. (Slide 6 - Relative Stability Map). The map classified land into three categories: stable, potentially moving, and moving. These categories were based on the natural stability of the land, that is, in a condition undisturbed by man. In addition, the fault traces were shown. The applicant's geologist and the town geologist concurred that development should be designed to avoid the areas of deep landsliding, avoid bands 100 feet wide along the fault traces, and include careful design treatment for development on the areas of shallow landsliding.

The developer then prepared a development plan responsive to these geologic conditions as well as a host of other requirements of the town. (Slide 7 - Plan of Bovet Development.) The plan consists of small clusters of individual lots ranging from approximately 1/2 to 1 acre with substantial open areas to be owned in common and available to all the residents of the development. An important point here, is that the nature of the adopted general plan and the provisions of the regulations allowed the developer to use the good land and avoid the unstable land. The plan avoided the siting of residences on unstable and potentially unstable lands by leaving these areas as open space. (Slide 8 - Bovet Development Plan with Stability Overlay.) In this process, the developer was penalized only slightly for having land that had so many geologic problems. The final design had a yield within 2% of the maximum yield of dwelling units that would have been permitted had no geologic problems been present.

This amount of review and information still is not sufficient to permit development on the Bovet Property. As each portion of this large development is undertaken, the applicant will be required to perform sub-surface explorations to substantiate or modify the data based on surface exposures and to provide the data necessary for adequate engineering design.

This degree of recognition of geologic faults and unstable hillsides, while perhaps not new to some other countries such as New Zealand, is relatively new to this country and the San Francisco Bay region. To underscore this point, let us look at a preliminary subdivision design for the property we have just discussed which was prepared in 1956 but which was never submitted for official approval. (Slide 9 - 1956 Subdivision Plan with Stability Overlay). This plan proposed an almost even distribution of lots over the entire property paying absolutely no heed to geologic problems. In all likelihood, this plan would have been approved in essentially this form in 1956, if not even more recently.

This is but a brief review of what one small but enlightened community is attempting to do to recognize seismic and other geologic problems. The Town of Portola Valley sobered through witnessing landslides in the local area which resulted in large property losses, has decided that a sound planning program must recognize geologic hazards.

These experiences have also pointed out, however, areas in which we need substantially greater knowledge and experience in order to adequately deal with geologic problems. Some recommendations are:

1. We need to determine what kind of geologic data is needed at each of the different geographic or governmental levels and also at the different stages in the development process. For instance, we need to know what kind of information is needed to plan for the San Francisco Bay Area region versus the kind of data necessary to plan for a small city. We need to know what kind of information is needed to make general decisions for developing large residential areas versus the kind of information needed for constructing a home on a given plot of land.

2. We need to determine the appropriate role of each level of government from the federal to the local level in applying geologic data in the land use decision-making process. We need to define these roles in terms of guidelines, administrative requirements and legislation.

3. We need to learn how to measure the amount of risk inherent in any given combination of potentially unstable land and any given land use. For instance, we need to know the comparative risk between construction of a single-family frame residence next to an active fault versus the construction of a market or a school. We must be able to define acceptable levels of risk to protect the public and private interests.

These are a few of the many tasks warranting our best collective efforts. The partnership between geologists and planners has only recently begun in this country. Experience in recent years, however, points out that further cooperation between geologists and planners can result in far improved physical environments for man.