

01-74-03 SIDE B

Symposium on Alaska earthquake 1964 with Warren George and William Schaem

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Warren George is introduced. Warren George's paper is titled "Effects of the Good Friday earthquake on Alaska soil." George talked about a volume of work that was just published about the slide areas of Anchorage. He said he will run through a summary of the Alaska U.S. Army Engineering District activities. He will also show slides of the physical destruction of the earthquake. He said to explain the earthquake and the slides that it produced in the Anchorage area in this brief time limits the detail of coverage. Some of the more important facts and investigation procedures that were used in obtaining basic data and the analysis undertaken to determine the slide mechanism and the conclusions reached will be covered. Much effort in programming, mobilizing, planning, exploring and testing in the execution of extensive investigation was required. Additional work is still indicated and considerable continued analysis and sifting of the large amount of data obtained before all the facts can be fully evaluated. The quake that triggered the slides took place at 5:36 p.m. on Good Friday. Its Richter scale ranges from 8.4 to 8.6 or more. The duration is believed to be in excess of four minutes and possibly as high as five minutes. Accelerations and other characteristics are not complete. The quake has been estimated to have released about twice the energy of the 1906 San Francisco Earthquake. The damage is estimated to be 400 to 750 million dollars. One hundred and fourteen people were lost. The late hour and the fact that it was a holiday for many people kept the death toll from reaching higher figures. The tides at the time were at their lowest phases which minimized impact on coastal communities. While the water levels in Seward reached well into the town and had disastrous effects if it had been a high tide more inundation would have occurred. The quake caused large changes in the

level of land masses in the area. In a region west of the hinged zone which consists of the Anchorage, Kenai and Kodiak areas the land did subside up to seven feet. The region east of the hinged zone the land rose as much as six feet. Extensive survey work will need to be accomplished to define the full scope of these changes and the effect on the land mass further inward. At one point on Montague Island a change upward of 33 feet was noticed and up to 40 feet. These examples give a measure of the magnitude of the tremendous forces at work. This disaster and the large amount of intelligence that can be developed from it have had immediate recognition by large and important segments of scientific and professional groups in and out of the government. A quake of such intensity and duration hitting the heavily populated and developed west coast areas would have tremendous disastrous results. While certain areas of the world and the United States are subject to more frequent quakes than others no area can feel secure. The U.S. Army Engineer District Alaska known as the Corps of Engineers was designated by the Office of Emergency Planning to undertake the rehabilitation work of all public properties that came under OET responsibilities. One segment of this work covered the investigation of the large slide in the Anchorage area. The district sought and secured a broad cross-section of professional help to supplement its own soil and geology exploration staff in the investigation. Shannon and Wilson Incorporated engineering firm was selected. He listed personnel with the firm. Working closely with the operation was a group of foundation soils and geology structural men assembled from governmental agencies known as task force nine. It was headed up by Dr. Edward Echo from the U.S.G.S. William Schaem was in the Washington area. There were five major slides and a number of minor ones in the Anchorage area. Each major slide was studied by means of a drilling technique which resulted in a series of exploration holes placed along predetermined lines cutting across the slide. From this work profiles of the soil strata were developed. Two or more profiles were obtained on each slide. Core pressures were determined with instrumentation which have been read on a regular basis. Slope indicator apparatus had also been installed to secure knowledge of any subsequent ground movement. He de-

scribed the drill rigs used in the investigation. Bucket augers were also used to create open wells for observation. A deep trench was dug on one slide. There were approximately 234 holes involved in the operation. Samples were taken for classification and testing. Laboratory testing for classification and strength test and dynamic strength test took place. Other tests were conducted. It was shown that some of the layers of clay were very sensitive in certain layers and the sand layers in some areas were subject to quick conditions developing. He described testing for procedures. All slides except one were horizontal slides. Land movement varied considerably. Land subsidence occurred in the 4th Ave and the LK slides and an equally damaging multiple series grabens developed in the Turnagain slides. The zone of failure were determined by field investigation to be varied in depth. It was clear that the sand layers made quick from the high degree of agitation from seismic shock and clay zones made sensitive from the same forces. In the graben areas and in the pressure ridges at the toe of the slides much destruction of structures occurred. Damage from seismic shock to structures is another subject. Those designed with seismic consideration stood up reasonably well in minimizing the damage. He discussed the cracking pattern of the land mass in Turnagain Arm. From instrument and eye-witness accounts the slide stabilized after the seismic impulse ceased. Localized earth movement will continue to occur as the disturbed zones settle. Aerial photography and ground surveys were made to provide a steady basis of land movement and crack patterns. They had aerial photography from before the quake for comparison. They discovered earlier slides that had occurred. He said he will comment on the soil information gathered. Each slide had a glacial outwash. It varied in thickness from a few feet in west Turnagain to 70 feet on Government Hill. This mantle was underlain with a formation of silty clay of varying thickness commonly known as the Bootlegger clay deposit. The upper layers of this deposit were found to be somewhat stiffer than those of an intermediate depth. Those of a lower layer had a stiffer characteristic. The intermediate layers were generally quite sensitive although their sensitivity varied with location. In all clay deposits sand lenses of varying thickness were found. These did not always

appear to have extensive lateral continuity. The clays do not extend under the Anchorage area, but generally exist along the coastline and tend to thin out and disappear at varying distances inland from the shore. In the specific zones of failure the clay lost its sensitivities to the remolding process the clays above and below this zone still retains this property. The study of possible treatments of the slide has had considerable analysis. It appears that by grading, draining, and buttressing the 4th Ave slide can be economically protected from additional sliding induced by seismic disturbance by no greater intensity than the quake under consideration. A design has been prepared for this. The Alaska State Housing authority is the agency responsible for this work. They have worked closely with this organization. The buttress treatment is not economically feasible for the LK area. There is a possibility that the Turnagain area can be buttressed and made safe. They hope to start work on this shortly. The Government Hill slide is susceptible to treatment without large sums of money. Grading and draining will accomplish the necessary strengthening. This work has not been programmed so far. A solution to the 1st Ave slide is still not final. The slide came very close to the Native hospital. The slides although costly and involving the loss of human life do have the importance of alerting the community to the danger. This information can be used for future planning of the expansion of Anchorage.

Announcements about commercial exhibits

William Schaem's paper is titled "Structural design problems associated with the Alaska Earthquake." Dr. Schaem is introduced. He said he will not discuss the specifics of the earthquake since everyone has heard that information. He wanted to repeat that the information that the Alaska earthquake was greater than the 1906 San Francisco and equal to the 1960 Chilean earthquake. He said Mr. George pointed out the fact that the death toll wasn't any higher because of the time of day. He would like to expand on that. If the earthquake had occurred when schools were crowded then the deaths would have been

higher. By the same token if it had occurred later at night particularly in the military installations the death toll would have been higher. Tragic is a word used for the destruction, but it could have been worse. Within hours following the quake the area was invaded by scientists and researchers. Included in this multitude were structural engineers trying to seek the causes for the failures and trying to find out why some buildings survived as well as they did. What they saw as structural engineers was a wide variation in the application of the art of seismic design and construction. No matter how much they try to divorce the two in their thinking or in their approach in the finished structure they can't do it. The best designed building if not properly constructed is in trouble from the beginning. And conversely the best construction practices can not save a faulty design resulting in a potentially hazardous building. In evaluating the response of various structures to the Good Friday earthquake we observed that the one or two story structures performed a lot better than the larger and taller buildings. This doesn't apply to buildings that were located directly over or on fissured ground. Smaller structures have a relatively short natural period and the earthquake was deduced to have had a long period of slow acceleration value. If Anchorage was located closer to the epicenter then there would have been more damage to the one and two story buildings. He said he would talk about the variety of damage observed in buildings from relatively little damage to total destruction. There were two general problem areas. One is basically design to construction practices. He listed several examples. There were improperly designed and/or constructed masonry walls. Connections between various building elements were frequently ineffective. He thinks they need to raise the coefficient that they use for framing. He said the review of basic seismic design may be required. Thick concrete slabs were bent. He cited several construction problems such as poor cleaning at construction joints so there was shearing and cross bracing not connected correctly.

Schaem said they don't know the duration of the earthquake. They have developed a generally accepted code for the design of earthquake resistant structures. Even this code is not based on the maximum possible earthquake nor does it guarantee total prevention

of damage. It is intended to minimize damage and to prevent structural collapse. The present building code may not be perfect, but it is the best guide to follow for structural design. Interpretation is left up to the individual designer. There may not be understanding or the designs were not carried through. The structural designer should not especially in seismic areas accept unproven or questionable concepts. He said in seismic areas it should be considered good design to have a building look like it is laterally stable. He discussed the problems of building on marginal land. There should be adequate study of soil conditions. Zoning regulations must be in place. Structural engineer responsibilities are listed. One of the glaring problems that came out of the Alaska earthquake was in the field of utilities. Recording ends before the talk is finished.