SOIL MECHANICS AND FOUNDATION ENGINEERING ASPECTS OF THE ALASKAN EARTHQUAKE OF MARCH 27, 1964

by Ronald F. Scott[1]

SUMMARY

This report begins by briefly summarizing the geology and soil profiles of the Anchorage area. The most important effects of the earthquake with respect to soil engineering are then qualitatively described and illustrated and a brief discussion of the stability of slopes in the region of interest is presented.

INTRODUCTION

The author was a member of a team of engineers formed by the Office, Chief of Engineers, U. S. Army Engineers, to study the effects of the Alaskan earthquake on the soils and structures in the region of Anchorage, Alaska, with particular reference to the military bases. This paper, however, deals only with the behavior of the soil of the Anchorage area. A map of this area is given in Fig. 1, while Fig. 2 shows some of the features of the earthquake in the immediate vicinity of Anchorage.

At the time of writing, only a limited amount of data on soil properties is available, so that numerical calculations have not so far been possible.

GEOLOGY AND SOIL PROFILE

Geology

The rock and soil structure in the immediate vicinity of Anchorage, Alaska has been described by Miller and Dobrovolny (1). Briefly, bedrock, consisting of metamorphic rocks of pre-Cretaceous but probably Mesozoic age, outcrops about 7 miles to the east of the center of the city of Anchorage at the base of the Chugach mountains, which are composed of these rocks. The exposed bedrock runs approximately in a north-south direction.

In the Anchorage area a different unit, Tertiary bedrock, consisting of unmetamorphosed beds of coal, shale and sandstone, is covered to depths of several hundred feet (700-800 ft at West Power Plant Well, Elmendorf Air Force Base) by glacial and alluvial fan deposits of Pleistocene and Recent ages. Many moraine deposits are present. These materials,

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(1) Miller, R. D., and E. Dobrovolny, "Surficial Geology of Anchorage and Vicinity, Alaska," U.S.G.S. Bulletin 1093, 1959.

which would be classified as "soils" by a soil engineer, were laid down in several periods of glaciation, the last of which covered most of the underlying material with an outwash layer of sand, gravel, or sand and gravel varying in thickness from 10 to 50 or 70 ft. A crude profile, constructed from the well logging information in Reference 1 is shown in Fig. 3. The city of Anchorage is built on this relatively dense coarse outwash soil, which forms a generally level terrace 75 to 100 ft above mean sea level. Erosion by the sea along the coast, and by rivers has cut into the unconsolidated glacial deposits to form cliffs or bluffs 50 to 70 ft high along the coast and adjacent to the stream channels.

Miller and Dobrovolny (1) conclude that the relatively great depth of bedrock in the Anchorage area could not be inferred from the elevation of bedrock exposure to the east of the city and the gentle dip of the beds, and mention the possibility of a bedrock fault running between the foothills and the city.

The glaciated valley forming Turnagain Arm to the south and east of Anchorage is presumably filled to approximately the mean water level with similar glacial deposits, overlaid by estuarine silts which form extensive mud flats. The road and railroad to Portage run along the north side of Turnagain Arm and cross regions of exposed bedrock as well as areas of estuarine, glacial, and alluvial deposits. Both routes are situated at elevations 10 to 50 ft above mean high water along most of the distance to Portage.

At Whittier the metamorphic bedrock probably consisting of slates and graywackes outcrops at distances up to a few hundred feet back from high water level, and is reportedly (2) covered by varying thicknesses of glaciofluvial deposits of sand, gravel and cobbles.

Soils

Proceeding down from the surface, the soil profile in the Anchorage area generally consists of a relatively dense sandy gravel layer to a depth of up to 100 ft in some areas, although the common range is 20 to 70 ft. This gravel layer becomes thinner to the southwest, disappearing northeast of the International Airport and just to the west of Turnagain Heights subdivision. The surface layer in Turnagain Heights appeared on visual inspection to be predominantly a fine to medium sand. Possibly the gravel layer becomes progressively finer-grained, diminishing at the same time in thickness, to the southwest of the city.

Under the gravel is found a layered, light grey silty clay containing lenses and layers of silt, sand and sandy gravel to, in places, depths of 200 to 300 ft below the surface. This clay is termed Bootlegger Cove clay, and contains chlorite, mica, and mixed layered chlorite-montmorillonite clay minerals (1).

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(2) Long, E., Soil Engineer, District Engineer's Office, Anchorage, Alaska, personal communication.

The clay layer, according to Reference (1), outcrops along the bluffs along Bootlegger Cove (Turnagain area), between Chester and Ship Creeks, and to the north of Ship Creek. It is also exposed on both sides of Ship Creek for a distance of about 1-1/2 miles from the coast and makes appearances along the south side of Chester Creek for a half mile inland, and along Fish Creek for about a half mile. The Bootlegger Cove clay layer is present to a considerable thickness under the city of Anchorage and in the Turnagain area but decreases in thickness towards the southeast, particularly along Chester Creek, where it disappears altogether about half a mile to the east of Spenard.

Miller and Dobrovolny (1) favor the hypothesis that it was deposited in a freshwater glacial lake, rather than in an estuarine or marine environment. They point out that the evidence for this is inconclusive, however. The upper 2 or 3 ft is oxidized to a yellowish-grey color. Test results reported in References (1), (3) and (4) indicate that the Bootlegger Cove clay has a liquid limit water content in the range 25-40%, a plastic limit water content in the range 18-22% and a natural water content between 20 and 25%, indicative of a clay of medium plasticity. The variation from sample to sample is due to the content of silt present.

Up to the time of writing this paper, few data were available on the strength properties of the Bootlegger Cove clay, but information was generously supplied by S. D. Wilson (5) on the shearing strength of the clay versus depth as determined from 7 boreholes in the city of Anchorage; these results were obtained from unconfined compression tests on undisturbed samples and are shown in Fig. 4. The clay has a ratio of undisturbed to remolded shearing strength of about 4 and may therefore be classified as moderately sensitive. However, this does not correspond to the extreme sensitivity of the Laurentian or Leda clays of eastern Canada or the "quick" clays of Norway. The relatively low values of the Bootlegger Cove clay's natural water content and Atterberg limits also suggest that its formation and structure are not those of the extrasensitive "quick" clays. Since the origins of the Bootlegger Cove clay and the quick clays are similarly glacial, the hypothesis of Miller and Dobrovolny that the Bootlegger Cove clay was deposited in fresh water, as opposed to a marine or estuarine environment (in which the "quick" clays were laid down), appears to be reinforced. No estimates of the present salt content of undisturbed Bootlegger Cove clays are available.

The appearance of the strength versus depth curves of Fig. 4 is similar to that or a normally consolidated clay which has been dried out,

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(3) Unpublished U. S. Army CRREL report on Elmendorf AFB.

(4) "Preliminary Report, 27 March 1964 Earthquake in Greater Anchorage Area," Engineering Geology Evaluation Group, Anchorage, Alaska, April, 1964.

(5) Wilson, S. D., personal communication.

and consequently overconsolidated, in the upper layers. The oxidation of the upper few feet of the clay profile also points to some desiccation. It is possible that the clay is normally consolidated below a depth of between 0 and 20 ft above mean water level, and overconsolidated above that depth. The ratio of the increase in unconfined compressive shear strength with increase of effective stress is approximately 0.20-0.25 from Fig. 4 and this, for a plasticity index of about 20, is consistent with the relationship for a normally consolidated clay found by Skempton (6).

Where it is present, the Bootlegger Cove clay overlies morainal till or sand and gravel layers, into which most of the water wells of the area penetrate; in the absence of clay, the upper sand and gravel outwash directly overlies the geologically earlier sand and gravel moraine material. Under the sand and gravel layer is found glacial till material up to two or three hundred feet in thickness resting on bedrock.

Groundwater and Porewater Pressures.

From the well data of Reference (1) the permeability of the sand and gravel layers ranges from 10^3 to 10^4 ft/yr, which corresponds to values expected for such a material. Insufficient information has been available to the author by the time of writing to enable him to construct a detailed picture of the groundwater conditions in the vicinity of Anchorage, but the well log data summarized in Reference (1) permit a description of the possible groundwater situation according to the rough sketch of Fig. 5. The source of groundwater is run-off water from the mountains to the east of the city, in addition to infiltration from rainfall and melting snow on the ground surface. Groundwater flow probably takes place in general from the mountains to the coast, and the water moves through the more permeable soil layers. Since the clay deposit is both under- and overlain by sand and gravel layers, available groundwater is found both above and below the clay. The wells which penetrate below the clay layer seem to indicate a static water level some 10 to 40 ft below ground surface, and the place-name "Artesian Village", found on Anchorage maps, together with the mention (1) of surface springs west of the Prison Farm, located south of Artesian Village, provide evidence that in places, the static water level would be above ground surface. Reference (1) mentions springs along the bluffs.

As a consequence of these groundwater conditions, the porewater pressures ("static" water level) in the various pervious layers of sand, and in the sand and gravel below and within the Bootlegger Cove clay probably fluctuate seasonally as the water supply and withdrawals vary. Because of the rate of flow in, and the compressibility of, the various soil

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(6) Skempton, A. W., 1957, relationship shown in Scott, R. F., "Principles of Soil Mechanics," Addison-Wesley, Reading, Mass., 1963, p. 365.

layers, there will be time delays between the increased supply (or head) of water made available by melting snow in springtime at the base of the mountains and the resulting increases in pressure in the pervious layers below and within the clay in downtown Anchorage and along the bluffs. The duration of such time delays cannot be estimated at present, since no information is available on the fluctuations of water level and withdrawals in Anchorage wells.

The pore pressures in the sand and gravel layers within and below the Bootlegger Cove clay significantly affect the stability of all slopes and bluffs in the Anchorage area, and no definite numerical conclusions regarding their safety or otherwise under static or dynamic conditions can be reached without much more information on the normal level and behavior of these pressures. In addition, according to Reference (1), in a well a few hundred feet from the bluffs of Turnagain Heights the water is said to be "brackish", so that some salt water intrusion may be occurring at this location.

Soil Freezing and Thawing.

The mean annual temperature of Anchorage is 35.3°F, and, as might be expected, no permafrost is found in the winter, although in the coarser surface materials annual depths of freeze may reach 10 ft. At the time of the earthquake in 1964, the depth of frozen soil at Anchorage seems to have been in the range of 5 to 8 ft depending upon local climatic and soil conditions. Ground thawing usually begins at the end of March or in the first two weeks of April. No information is presently available on the beginning of ground thawing this year (1964), although surface thawing had certainly begun by the time of the author's visit, April 6.

OBSERVATIONS OF EARTHQUAKE EFFECTS.

The Earthquake

The earthquake originated at 5:36 p.m. Alaska Standard Time on 27 March 1964 (03:36 GMT, 28 March), had its epicenter at 61.0°N and 147.7°W and has been assigned a magnitude of 8.4 to 8.5 on the Richter scale (4, 7). The depth of the focus is estimated to be approximately 20 kilometers below the surface (7). Anchorage is therefore located about 80 miles from the epicenter, Portage about 45 and Whittier about 35. No seismic instrumentation was operating in the Anchorage area at the time the earthquake occurred so that no data are at hand on local acceleration levels attained, or duration of shaking. However, in conversation, several residents of Anchorage said that the severe shaking lasted from 2 to 4 minutes. The record of the kilowatt meter at the Whittier Power Station

(7) "Preliminary Report, Prince William Sound, Alaskan Earthquakes, March-April 1964," U.S. Department of Commerce, Coast and Geodetic Survey, Washington 25, D.C., April 17, 1964.

was studied; it seemed to confirm that the power station vibrated for several minutes. Observations of building damage at Anchorage apparently indicate that the ground movements experienced there were of relatively long period.

Calculations based on data on an Anchorage bluff and soil profile supplied by S. D. Wilson (5) indicate that a static horizontal force approximately equivalent to 0.1 of the vertical gravitational forces would cause instability of the slope. Observations of standing and fallen uncemented headstones in the cemetery in Anchorage provide crude evidence that accelerations of this level were probably reached.

Soil Behavior

At no location in Figs. 1 and 2 was there observed to be any sign of damage to a structure, with the possible exception of an oil tank at Whittier, due to local small-scale footing or foundation failure. All the structures affected by soil movements were in areas of large-scale ground movements due to landslides and slope failures.

(a) City of Anchorage

The principal ground movements in the city are located on Fig. 2 and are illustrated by photographs discussed below. The soil movements appear to have been of three types, by spreading, lateral displacement, and by rotation, the failure mode in each case being a function of unknown ground motions during the earthquake, relatively poorly defined (at present) soil profiles and properties, and unknown static porewater pressures in soil layers prior to the earthquake.

The snow cover on the ground prior to the earthquake made surface cracks and the displacement of the surfaces of soil blocks very easy to recognize and examine on photographs. Since the upper surface of the soil was frozen to depths of 5 to 8 ft, the movement of the underlying materials caused the frozen surface layers to break up in a brittle fashion, into slabs and blocks. It is possible that much of the observable cracking in many areas is due to this behavior of the frozen crust.

Sand blows were reported near the Knik Bridge on the road to Palmer and elsewhere (2) but were not seen by the author.

At Turnagain Heights the very large landslide, part of which is s shown in the aerial photograph of Fig. 5 and from the ground in Fig. 6, appears to have been of the laterally spreading type which has been known to occur (8) as a result of high pore pressures in a relatively pervious layer or layers underlying the sliding mass. In this case the excessive pore pressures may have been generated by the shearing of such layers due

[8] Terzaghi, K., and R. B. Peck, "Soil Mechanics in Engineering Practice," Wiley and Sons, New York, 1948, pp. 366-370.

to the earthquake ground motions. Alternatively, it will be observed that the normally consolidated-desiccated soil profile exemplified by Fig. 4 shows a minimum shearing strength at some depth (approximately mean water level in that case). The earthquake may also have caused a reduction of the shearing strength of the clay at that depth due to increased pore pressures as shearing deformation progressed. The sensitivity of the clay, or lowered strength on remolding, arises from the same phenomenon.

Typically, such spreading failures occur very rapidly, in minutes, so that it is not possible to say whether the Turnagain slide, having been initiated by the earthquake, stopped with the cessation of the vigorous general ground motion or continued after it. It does not seem likely that the landslide terminated before the earthquake. For equal ground motions it would appear that the bluffs at Turnagain were less stable than at other locations as a result of weaker soils or higher static pore pressures. Assuming a minimum cohesive shearing strength, c, for the Bootlegger Cove clay of about 1000 psf and a unit weight, γ, of about 125 pcf (5), the bluffs at Turnagain certainly had a height which exceeded the minimum value for stability ($4c/\gamma = 32$ ft) for the case of excessive pore pressure in an underlying layer (8).

The L Street and 4th Avenue slides underwent lateral soil movements much smaller than those at the Turnagain slide. In each case a very large mass of soil, including a part of the bluff and relatively flat slopes at the toe, moved laterally without much rotation for a distance of perhaps 10 to 12feet. The soil behind the new cliff formed at the head of the slide was left unsupported thereby and failed causing a section (graben) behind the slide to fall down into the space provided by the lateral movement. This behavior in some areas has repeated itself to a diminishing extent behind the primary slide block, causing successive groups of cracks and grabens. The graben of the 4th Avenue slide and its effects are shown in Fig. 7.

Naturally, buildings have been severely damaged in the region of down-dropped blocks and at the toe of the large sliding blocks where bulging and upthrusts have occurred but, to the author's knowledge, no substantial steel frame or reinforced concrete buildings existed in such locations except for a reinforced concrete building near the top of the 4th Avenue slide. Most of the destruction was confined to wooden frame and cement block structures. Both the L Street and 4th Avenue landslides, having undergone relatively small movements, appear to have been just unstable under earthquake conditions. The shearing movement seems likely to have taken place on a horizontal layer of weak soil, or one in which substantial hydrostatic water pressures existed.

The Government Hill and 1st Avenue slides, the latter of which is shown in the aerial photograph, Fig. 8, both appear to be examples of simple rotational slides. Such slides typically occur over longer times than flow slides, up to several hours, but at Anchorage the movements and earthquake were probably contemporaneous. More noticeably than at other locations, other older rotational slides are observable in Fig. 8 adjacent to the most recent one at 1st Avenue. Examination of local records might indicate whether or not the more recent of the previous slides occurred as a consequence of an earthquake.

(b) Portage Road

A stop was made along the road to Portage, approximately at Rabbit Creek, to examine the slide on the Alaska Railroad along the shore north of that point. This appeared to be a sand and gravel flow slide in the bluffs and in the fill supporting the railroad tracks. The tracks were displaced perhaps 50 ft towards the water and 10 to 15 feet vertically downward. It was obvious on examining the site that at least two slides had occurred at that location previously, one quite recently. Slides along the railroad in this area during the 1954 earthquake are mentioned in Reference (1). From the nature of the repair procedures in operation at the time of our visit, it would seem likely that slides will occur at this site again in future.

The condition of the road and bridges to Portage gets progressively worse as Portage is approached. Up to perhaps 10 miles from Anchorage, damage is confined to some slumping of approach fills and settling away from abutments, while the bridges are relatively intact, as shown in Fig. 9. Further on, as a result of the slumping of the road shoulders, large cracks appear in the highway and underlying base course, which is, of course, frozen to a depth of several feet. Such a crack is shown in Fig. 10. By this stage, most of the road bridges, which are made of reinforced concrete supported for the most part on wooden piles, had collapsed into the streams which they crossed, Fig. 11. In some cases, the ground movements vibrated the bridge off the piles so that the deck fell upon, and was impaled by, the piles. From visual inspection, the tops of the piles were not at levels obviously different from those to which they had originally been driven. The bridges on the railway, running for the most part alongside the road, were either trestle structures or steel on wooden piles, and had not been damaged to the same extent as the highway bridges.

Considerable ground cracking was evident both across the road and in open ground at Portage. The journey to Portage was made at a time spanning high tide in Turnagain Arm, a few days before the spring tides, and it was observed that the water level was much higher than in the past. This could be due to land level changes as a result of tectonic motions accompanying the earthquake and/or settlement or densification of the glacial soil deposits filling Turnagain Arm as a consequence of earthquake vibrations. A vertical movement of several feet resulting from vibration-induced settlements would not be unlikely, but a detailed evaluation must await precise surveys of rock outcrops as well as bench marks established on soil. The cracks at the ground surface in the Portage area are a consequence of the presence of the brittle upper layer of frozen ground and though they most probably develop from the differential settlements in different soils, they may also arise from the fracture of the surface during transient stress conditions.

Several snow slides had taken place along the Portage road during the earthquake. These were reported to have travelled further out from the toe of the slope than the slides which usually occur in late winter.

Since the past winter had been one of lighter-than-normal snowfall, the presence of broken trees in some of the slides also indicated that the slides had not all followed customary paths.

(c) Whittier

No unusual snow or rock slides were observed during the flight to Whittier. At Whittier the oil tanks at the head of the Passage inlet were examined; one of these was said to be leaking following the earthquake and was noticed to be tilted. It was at least partially full at the time of the earthquake and therefore it must be deduced that some soil movement had taken place below it. Other tanks, also containing liquid, were undamaged, but no detailed soil information on the tank foundations was available. At Whittier, the 6-story Brucker building was founded on bedrock, while a 14-story taller reinforced concrete structure was reported to be founded on 20 to 50 ft of dense sand and gravel over bedrock. The damage to the larger building seemed to be less than that suffered by buildings of similar construction and size in Anchorage, considerably more distant from the earthquake. This result may be attributable to the depth and type of soil at Anchorage in contrast with the relatively shallow depth at Whittier or to differences in the strengths of the structures.

A cross section through the wharf at Whittier is shown in Fig. 12, and Fig. 13 shows typical damage to the floor slab of the warehouse behind the wharf. It appears that the fill on which the warehouse floor slab rested underwent some compaction during the earthquake and settled away from the floor, which broke for lack of support. It is also possible that the ground shaking induced oscillations of the wharf structure and sheet-pile wall to and from the fill, assisting in its compaction and imposing lateral stresses on the unsupported floor slab, which, deflecting downwards, buckled as shown in Fig. 13. Movements of the latter kind would seem to be unlikely if the tie-rods and earth anchors to which they were attached were adequately placed and were sound before the earthquake. Since the tie-rods apparently passed unprotected through the fill below the warehouse, it is possible that they had been damaged before the earthquake and did not contribute full support during it.

CONCLUSIONS

A large portion of the earthquake damage to structures in Anchorage was caused by slope failures and landslides initiated by ground movement. Failures occurred in the vicinity of bluffs and slopes whose factors of safety under static loading appear from approximate preliminary analyses to have been in the range of 1.0 to 1.5.

It also seems that relatively high pore water pressures developed in soil layers underlying at least some of the failure regions, either before or during the earthquake, and that these pressures contributed substantially to the flow slides which occurred. The static water level in pervious layers of soil below, or in, the clay or silty clay strata in the Anchorage area appears to be fairly close to ground surface as a result of the overall groundwater flow pattern of the region. Due to rainfall and snow melting this level probably fluctuates seasonally and may undergo longer period changes. The strength profile and moderate sensitivity of the Bootlegger Cove clay also played a part in the slide processes.

Little or no damage resulted to structures from local dynamic soil failures on the scale of footing or foundation size.

In and along the shores of Turnagain Arm, and by induction, along the other arms and inlets of the area, it seems likely that considerable settlement or compaction was caused in the glacial soils by the earthquake vibrations, in addition to any tectonic movements in the basement rocks. Slumping and sliding occurred in the railroad and highway fills and embankments constructed on these deposits.

During the shearing and distortion of the Bootlegger Cove clay participating in the slide movements (and possibly also in soil layers in the arms and inlets) high pore pressures have undoubtedly been generated. These pressures have been dissipating through drainage of the pore water since the earthquake. Consequently in all areas subject to sliding, settlements, possibly on the order of feet, may be anticipated. Such settlements will continue certainly for months, and possibly for years, depending on the soil properties and drainage conditions. In the regions immediately behind the slope failures both lateral and vertical soil movements may be expected for some time as the soil adjusts to the new stress conditions, and also as the pore pressures change.

The decrease in pore pressures has the favorable effect of permitting the soil to consolidate and increase in strength, so that, other factors excluded, all the failed regions will gradually increase in stability at a decreasing rate for some time to come. Other factors, in this case, include the drainage of surface rainfall and snowmelt into the cracks and crevices left behind failure zones, and the melting of the frozen surface layer. It is expected that local slumps and soil movements will occur as a result of the water pressure in such cracks and the melting of the frozen ground.

Unless suitable investigations and remedial measures are taken, future slope failures and slides in the Anchorage area may be expected under either static conditions, or as a result of earthquakes.

ACKNOWLEDGMENTS

The author acknowledges the assistance given him in this inspection trip by the Corps of Engineers, U. S. Army, and particularly by the Alaska District Office, Anchorage. His colleagues, Drs. C. Allen and S. Cherry were especially helpful in discussions of the geology of the Anchorage area and the structural damage caused by the earthquake, respectively.

FIGURE CAPTIONS

Fig. 1 Map of Anchorage, Portage and Whittier Region.

Fig. 2 Map of Anchorage Showing Soil Slide Areas (From Ref. 4).

Fig. 3 Approximate Cross-Sectional Soil Profile Showing Water Table, Anchorage Vicinity.

Fig. 4 Representative Shearing Strength Profiles, Anchorage, (From Ref. 5). The solid lines were drawn by the original investigators through the scattered data points. The fluctuations in shearing strength probably arise from changes in the silt or sand content of the clay. The dashed lines are the author's estimates of the strength increase with depth in the clay.

Fig. 5 Aerial View of Turnagain Slide Area.

Fig. 6 Turnagain Slide.

Fig. 7 Graben of 4th Avenue Slide.

Fig. 8 Aerial View of 1st Avenue Slide.

Fig. 9 Slumping of Approach Fills to Bridge on Portage Highway.

Fig. 10 Damage to Portage Highway (frozen to depth of several feet).

Fig. 11 Collapsed Bridge and Temporary Bailey Bridge on Portage Highway.

Fig. 12 Plan and Cross Section of Whittier Wharf.

Fig. 13 Damage to Floor Slab of Whittier Wharf Warehouse.

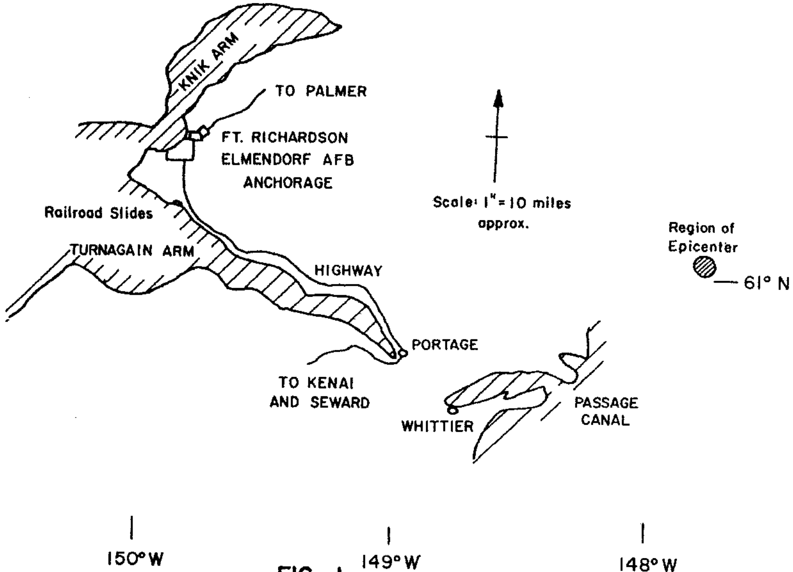

FIG. 1

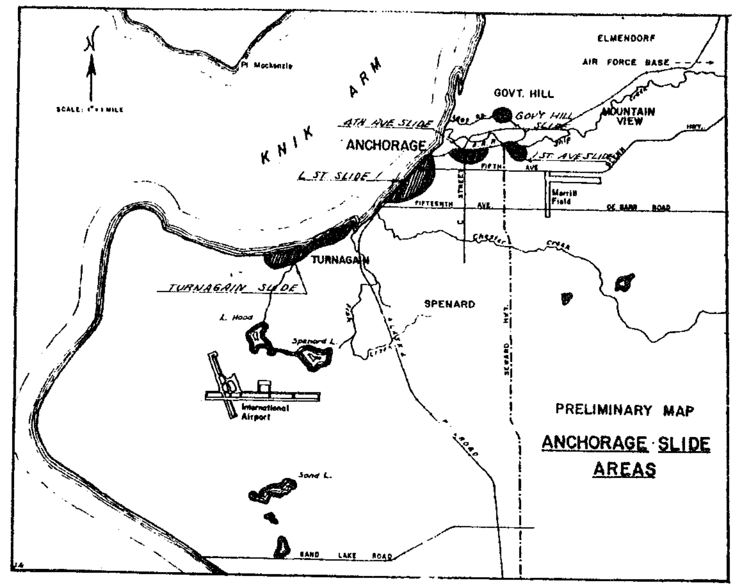

FIG. 2

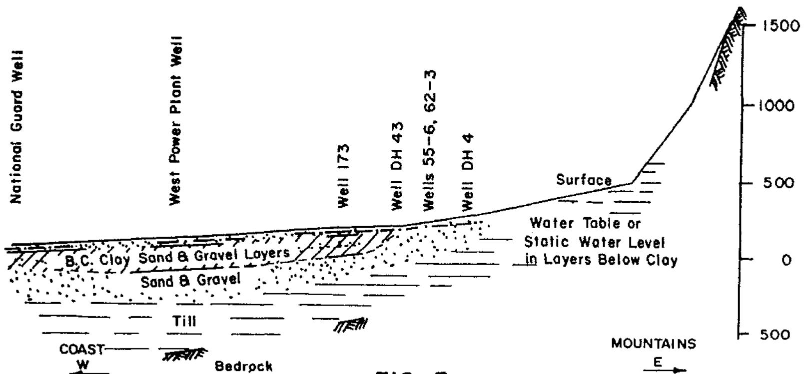

FIG. 3

HORIZONTAL SCALE: 1" = 1 MILE (APPROX.)

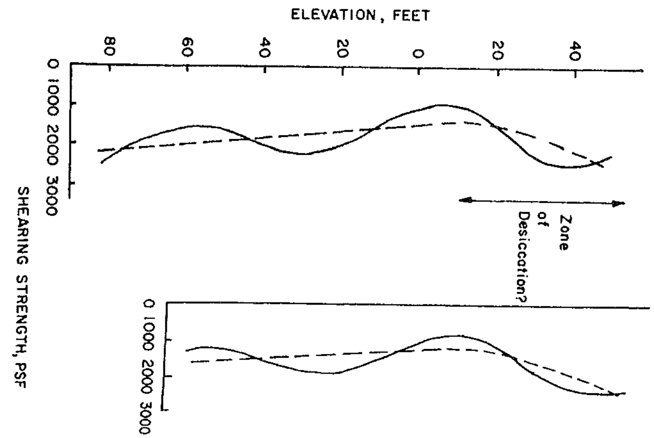

FIG. 4

FIG. 6

FIG. 8

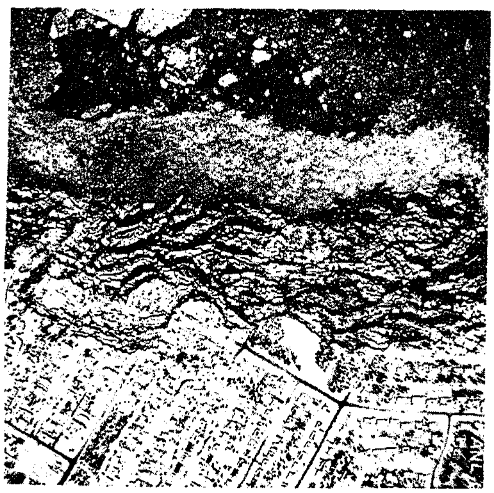

FIG. 5

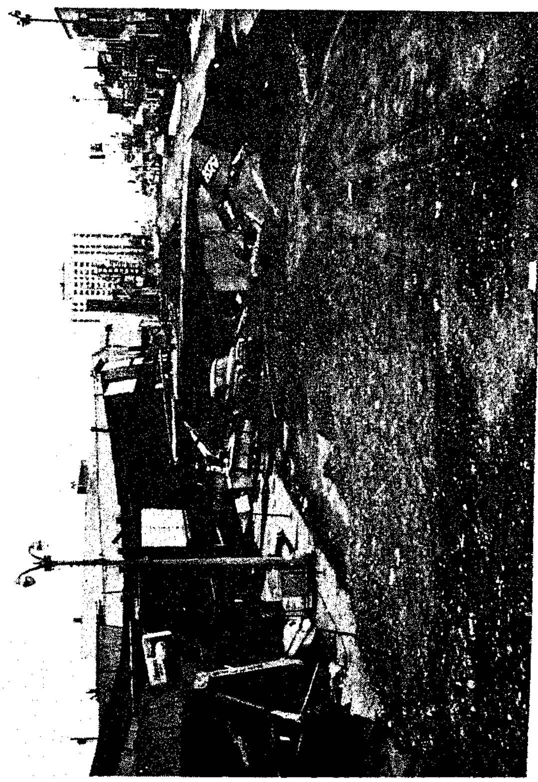

FIG. 7

FIG. 10

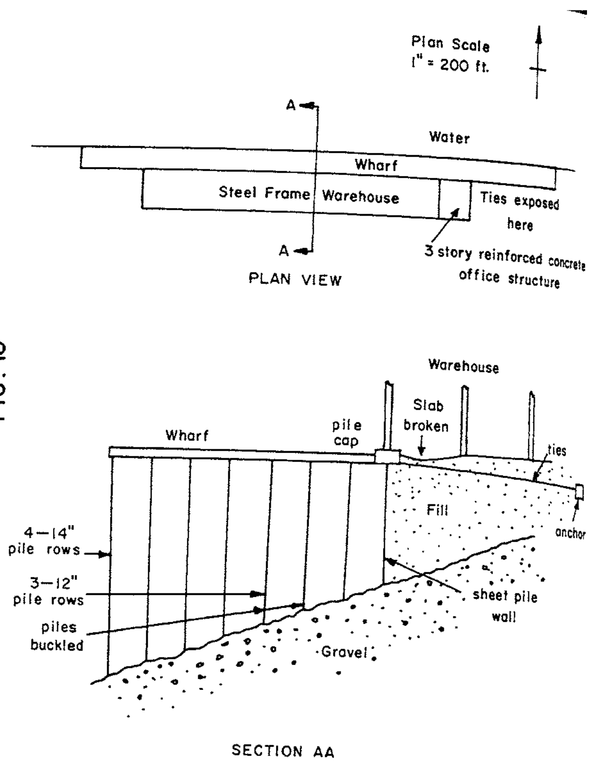

FIG. 12

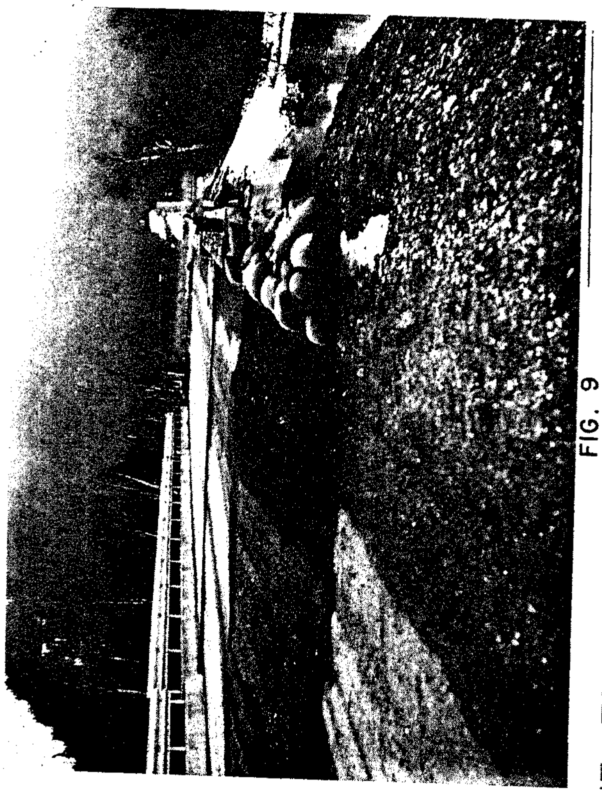

FIG. 9

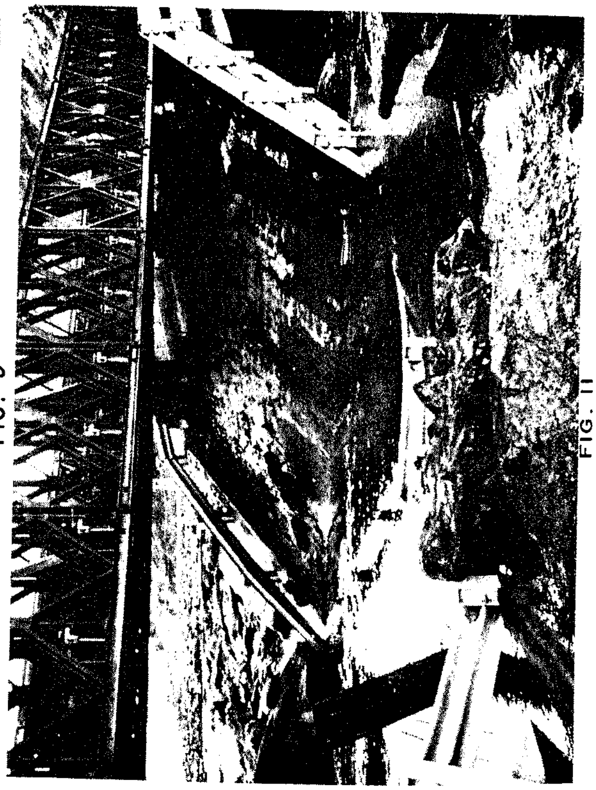

FIG. 11

FIG. 13

SOIL MECHANICS ASPECTS OF ALASKAN EARTHQUAKE OF MARCH 27, 1964

BY R. F. SCOTT

QUESTION BY: P.W. TAYLOR - NEW ZEALAND

The author has described how pore pressures are believed to have built up in underlying strata during the Alaskan earthquake. It would be expected that dissipation of these pore pressures after the earthquake would lead to settlements following the usual laws of Soil Mechanics. Were any such settlements observed, in fact?

AUTHOR'S REPLY: Not received.