6 SPECIAL GRADING INSPECTIONS AND INVESTIGATIONS

6-1 INTRODUCTION TO SPECIAL INSPECTIONS

Special grading inspections and investigations are those conducted by the grading staff for purposes other than mass grading inspection or at the request of other sections or divisions of the building department, or other departments or even other agencies. They encompass a wide variety of technical considerations, some of which are within the purview of grading inspectors, whereas others fall more readily within that of structural building inspectors. These inspections may be provided by structural building, zoning, or other inspectors because the inspections are apart from mass grading inspections. However, for efficient staff utilization, the inspections that involve earth sciences and geotechnical activities should be performed by grading inspectors or earth-science personnel. A structural building inspector rarely performs grading functions as well as a grading inspector, and vice versa.

This chapter covers such topics as current practices in utility trench inspection; footing excavation and under slab inspection; engineered-foundation inspection, including caisson and grade-beam construction; special drilling situations such as tie-backs; sub-drains; slope inclinometer indicator; mud-jacking; compaction and chemical grouting; sea-wall inspections; coastal bluff inspections; and abandonment of subsurface structures. Many textbooks are available on these subjects, and it is not our intent to duplicate those efforts. Rather, we do encourage improved utilization of building department staff in general, and grading inspectors in particular.

In addition to the special inspections, we discuss how to deal with complaint violation investigations and reporting, court and legal preparations, and expert witness or court testimony, which are common elements of building and grading-code enforcement. We again emphasize the proper utilization of public records for court presentation, as well as the conduct of the staff personnel while providing court testimony.

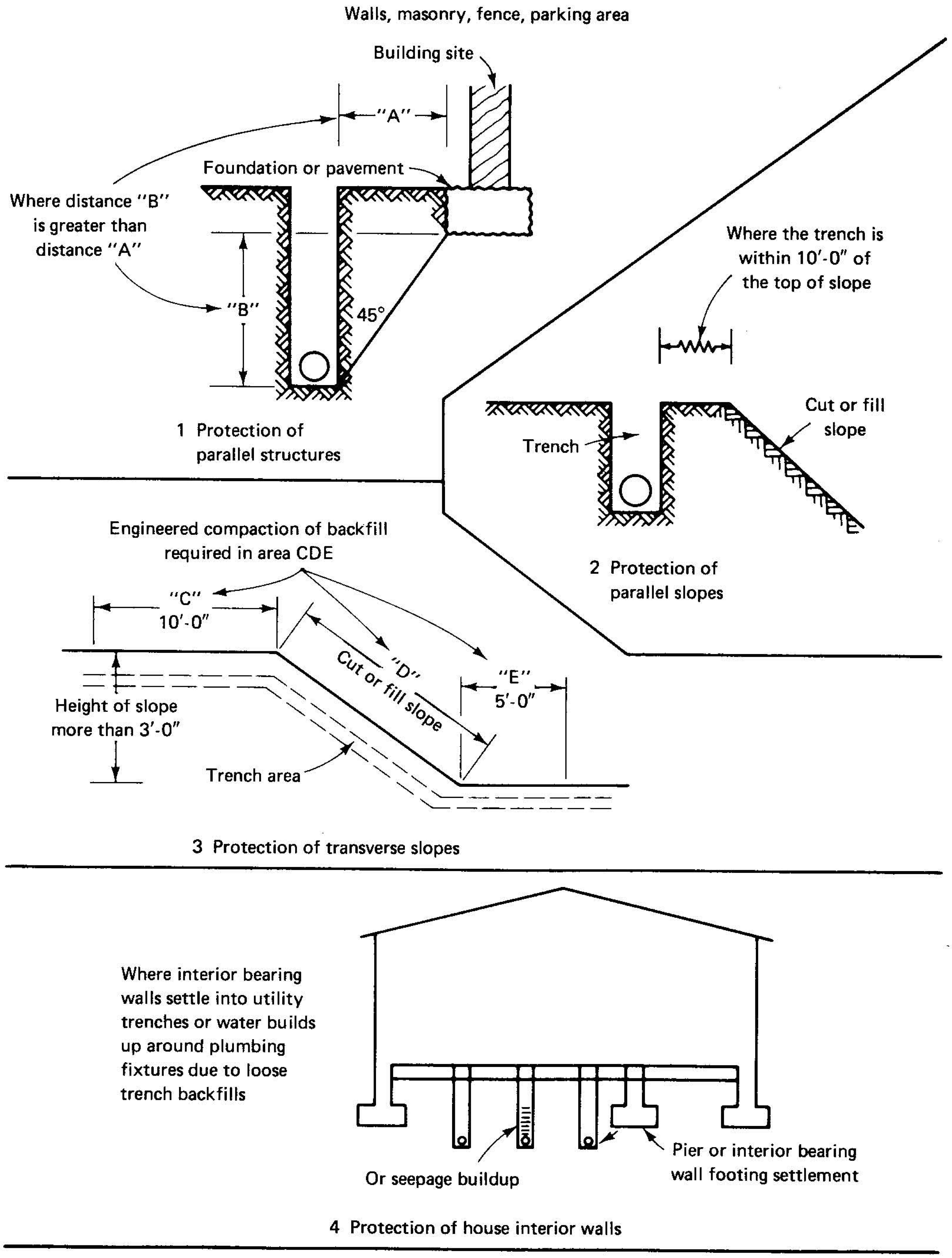


Figure 6-1 Trench backfill inspection. The compaction of backfill material in these potentially hazardous trenches should be tested and approved by a soil engineer.

Chapter 6 concludes with a discussion of private road grading and public right-of-way mass grading control in order to encourage safer grading control in the field. The method of mass grading control used by the County of Orange, California is described as an example of one that has produced very satisfactory results in the long-term performance of embankments and slopes.

6-2 UTILITY TRENCH BACKFILL INSPECTION

Inadequate compaction of backfills in deep utility trenches has caused slope failures and foundation failures in hillside areas. Some governmental agencies now require geotechnical supervision and testing of trench backfills to minimize such failures. Potentially hazardous trenches are those whose location will cause settlement and will structurally weaken foundations of any structures bearing upon them for support, or may cause slope failure due to water buildup in back of the slope face. These may include those trenches that allow erosion or buildup of water seepage behind slope faces (see Figure 6-3), or allow any water buildup within the interior of the house. The latter is normally caused by water ponding where utility trenches extend beneath the residence, allowing infiltration that causes settlement of interior bearing walls or causes water buildup around plumbing pipes, which in turn rots wall boards and/or damages carpets. (See Figure 6-1.)

The following are situations that most frequently result in slope and foundation failures. (See Figures 6-1 through 6-4.)

1. *Protection of parallel structures.* When the bottom of a trench is parallel to a footing, or a foundation is closer than a 45-degree angle to the bottom of such a footing or foundation (measured from the bottom of the footing to the bottom of the trench), the lateral support of that footing may be jeopardized. (See Figures 6-1(a) and 6-2.)

2. *Protection of parallel slopes.* Trenches adjacent to the top of any descending slope that runs parallel to the top of slope or within ten feet of the slope face is considered in jeopardy if the backfill is loose or uncompacted, as future surface water may penetrate the backfill. The water may seep into and behind the cut-slope or fill-slope face, increasing hydrostatic pressure and causing slope failure. (See Figures 6-1(b) and 6-3.)

3. *Protection of transverse slopes.* Any trench that crosses or is within an area of ten feet from the top or five feet from the bottom of a three-foot high or taller slope is potentially hazardous if backfill is not compacted tightly. Surface water seeping into uncompacted or loosely compacted backfill will erode the backfill out of the trench and divert the surface drainage flow to an adjacent lot, causing inundation of a portion of that lot. (See Figure 6-1(c).)

Figure 6-2 Utility trenches cut parallel to structure footings allow settlement of footings when backfill is not compacted tightly. Such compaction should be tested and approved by a soil engineer. Photograph by and courtesy of Robert W. Ross.

Figure 6-3 A sewer trench cut parallel to top of slope may allow water and seepage buildup behind the slope face if trench backfill is not compacted tightly. Seepage buildup may cause slope failure or water diversion. Photograph by C. Michael Scullin.

Figure 6-4 Loosely dumped backfill in sewer line trenches laid in the street area. These backfills are often compacted by water jetting which is rarely sufficient for adequate compaction and usually allows subsequent settlement. Photograph by C. Michael Scullin.

These three conditions are frequently manifested during development of hillside subdivisions. Therefore, the compaction of the backfill should be approved by the site soil engineer after rough grade is completed, and during building construction when the utility companies are constructing their lines into the building. (See Figure 6-2.) If compaction is not sufficient in cases where trenches extend within the building area, interior bearing walls may settle, or footings or foundations may settle into the uncompacted trench, causing distress within the interior of the building. (See Figure 6-1(d).) Sometimes during excessive rainy periods, ponded water seeps through the utility trench backfills and builds up in the bathroom areas where the plumbing facilities are located, causing bubbling of paint or cracking of the dry walls. Since the soil engineer is frequently not notified when the utility companies are constructing their lines and trenches, there must be close coordination between the building inspector and the grading inspector to assure that the site soil engineer is called back to test and approve these backfills to reduce or minimize these potential hazards. Approval of utility trench backfill by the soil engineer and approval of underground utilities by the plumbing, electrical, or mechanical building inspectors should be obtained prior to actual pouring of footings or slabs. Figure 6-4 illustrates the ultimate settling of a street area commonly caused by the loose backfill technique.

6-3 FOOTING EXCAVATION AND UNDER-SLAB INSPECTION

The grading inspector should inspect the footing excavation, depth and width, as recommended by the soil or foundation engineers. The inspector should inspect and measure the depth of penetration into competent bedrock where geological factors have dictated such penetration. (See Figures 6-8 through 6-10.) If expansive soils are involved, a requirement for pre-saturation of the footing and slab areas must be checked and determined by the soil engineer. For expansive soils, post-tensioned slabs are sometimes designed or recommended by the soil engineer. (See Chapter 8.)

As a part of the under-slab and footing inspection, the grading inspector should make sure that under-slab sand, visqueen plastic, wire mesh reinforcement, and footing reinforcement are in place prior to the pouring of the concrete. (See Figures 6-6 (a) and (b).) A curing agent such as Hunt's Process should be used to make sure that the concrete is properly cured.

Figures 6-7 through 6-9 illustrate footing excavations that have been deepened from the original designs to penetrate through soils and bedrock creep, and are founded in competent bedrock. This procedure often necessitates changes in wall design, such as:

Figure 6-5 A "breaker ram" attached to a backhoe is shown excavating footings in hard rock. Photograph by Frank E. Denison, geologist.

Figure 6-6 (a) An underslab area prior to paving. Underground utilities are shown in place and stubbed off for future connection. Plastic sheets cover the soil, and sand is stockpiled for spreading. (b) The underslab area is ready for the concrete pour. First, sand is spread over the plastic sheets; then wire mesh reinforcement is put in place. The wire mesh must yet be raised and seated on blocks or rock to assure that it is not pushed down to the bottom when the concrete is poured. Photograph by C. Michael Scullin.

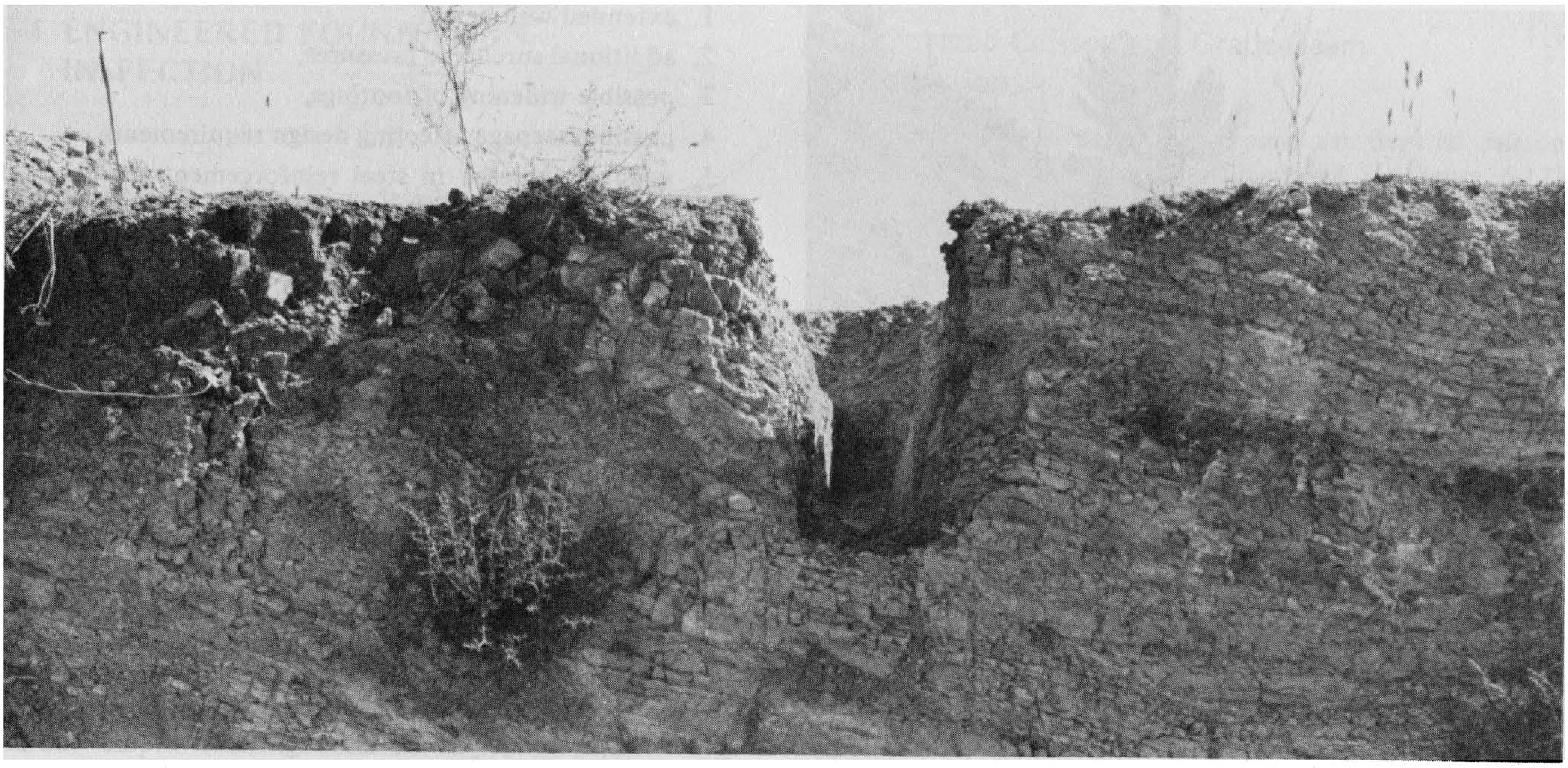


Figure 6-7 Footing excavation has been deepened through the near surface bedrock creep and is founded on competent bedrock. Photograph by C. Michael Scullin.

Figure 6-8 A retaining wall footing excavation is shown extended through loose soils and creep and founded on firm bedrock. Photograph by C. Michael Scullin.

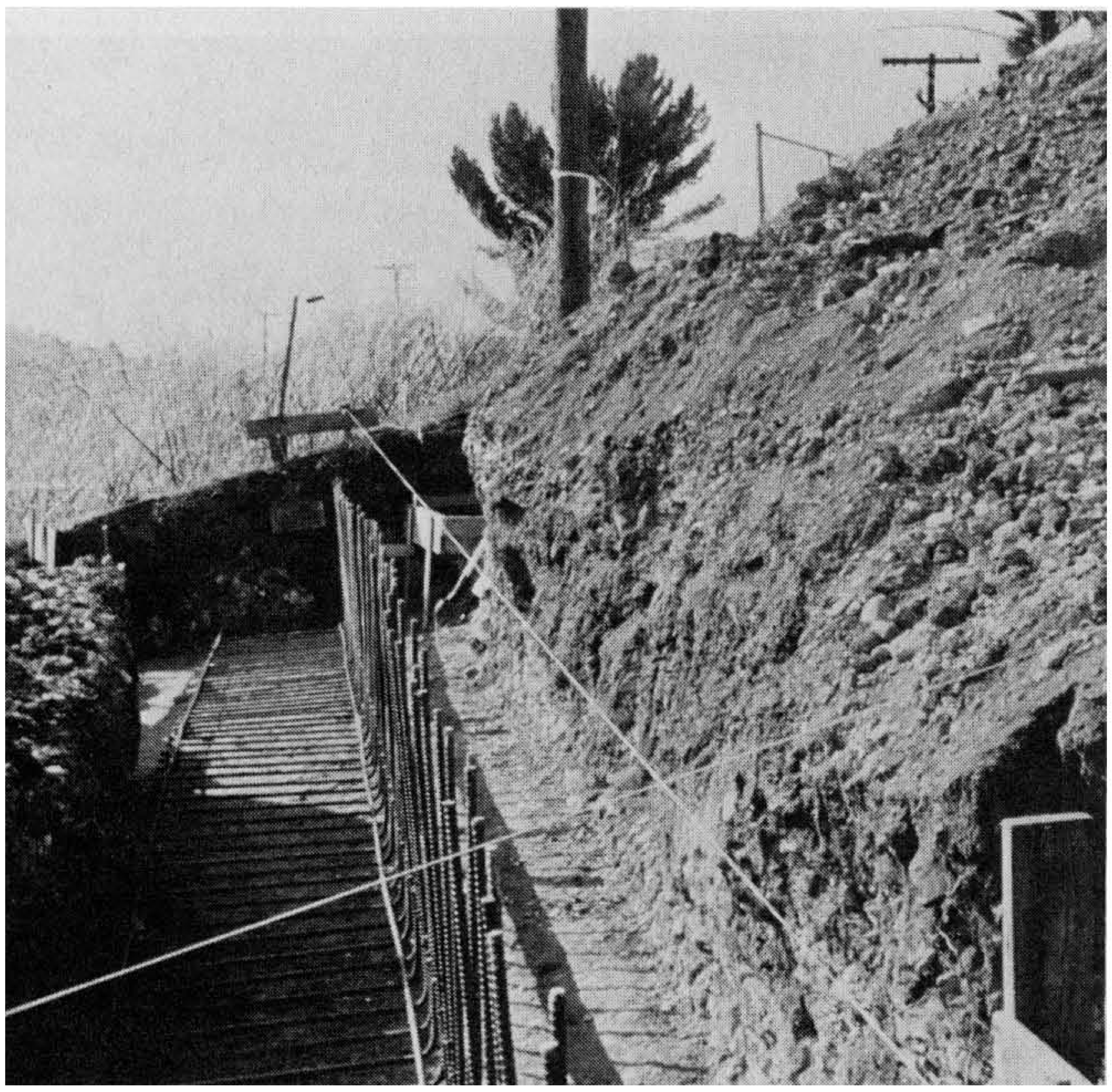


Figure 6-9 Retaining wall footings excavated through loose fill, surface soil, and bedrock creep. These footings are cut into competent bedrock. Photograph by and courtesy of Alex Bruce, senior building inspector, City of Los Angeles.

1. extended wall height,
2. additional surcharge pressures,
3. possible widening of footings,
4. possible seepage affecting design requirements,
5. possible increase in steel reinforcement requirements due to change of wall design.

In hillside construction the footing wall often has to be designed to withstand the lateral force load exerted by down-slope creep. When deepening such footings, the design must consider that the creep is acting against the footing wall. In cases of single-family residences cantilevered over the slope, caisson and grade-beam construction is normally designed for the down-slope creep or lateral force loading. (See Figure 6-11.) Figure 6-8 illustrates the deepening of foundations or footings through 2 to $2\frac{1}{2}$ feet of bedrock creep and founding them into more competent siltstone and shale. The near-surface bedrock can be seen to be considerably broken where, even though the competent bedrock is highly jointed, it is still relatively tight. Often these conditions are not detailed in the preliminary geotechnical investigation, although they should be. The grading inspector, who is more experienced in the geotechnical conditions than is the average building inspector, must be alert to these possibilities during inspection in order to make sure that foundations are founded into competent soil or rock material. The inspector may require footing excavation inspection by the geotechnical consultants to assure penetration into stable soil or bedrock.

Figure 6-10 Typical cantilevered residential construction founded upon caisson and grade-beam foundations. Such foundation and grade beam designs must provide for the near-surface lateral force loads exerted by down-slope creep. Photograph by and courtesy of Alex Bruce, senior building inspector, City of Los Angeles.

6-4 ENGINEERED FOUNDATION INSPECTION

We will not describe design details for caisson and grade-beam, point bearing piles, cast-in-place, or other types of engineered foundations. However, the grading inspector should require that the soil engineer or geologist recommend the depth of penetration of foundation or footing into competent bedrock in his professional geotechnical reports. The grading inspector should also require that geotechnical personnel inspect and measure the caisson holes in compliance with building design foundations, and provide the deputy inspection and approval of excavation and steel placement prior to concrete placement. This approval should describe the quality of foundation concrete to be required in the engineered foundation. These approvals should be made in writing by the geotechnical group prior to further construction, and there should be some coordination between the grading inspector and the building inspector relative to these approvals prior to continued building construction.

Cantilevered Caisson and Grade-Beam Construction

The original plan design for typical cantilevered caisson and grade-beam construction (illustrated in Figure 6-11) will normally have had geotechnical preliminary investigation based on the design, with all geotechnical factors incorporated within the design of the site. Conversely, structures that are being underpinned (Figures 6-11 through 6-14) probably did not have any form of geotechnical investigation prior to construction, and therefore need to have such a geotechnical analysis in order to determine the type of underpinning or engineered foundation necessary to provide the support. In some cases, such as in Figure 6-11, a hillside drill rig can be winched onto the site to excavate the caissons. However, in the case of Figures 6-12 and 6-13, there was no room for equipment to be brought in. Consequently, the four 4-feet-by-4-feet caissons around one corner of the house that was settling had to be dug by hand. In this case compacted fill resting upon compressible colluvial soil had caused settlement. The caissons were extended to 2 feet into competent bedrock to depths ranging from 17 to 20 feet among the four columns.

Figure 6-11 Drilling to underpin the rear foundations of an existing residence using a detached hillside bucket-auger drill rig. Photograph by and courtesy of Robert W. Ross.

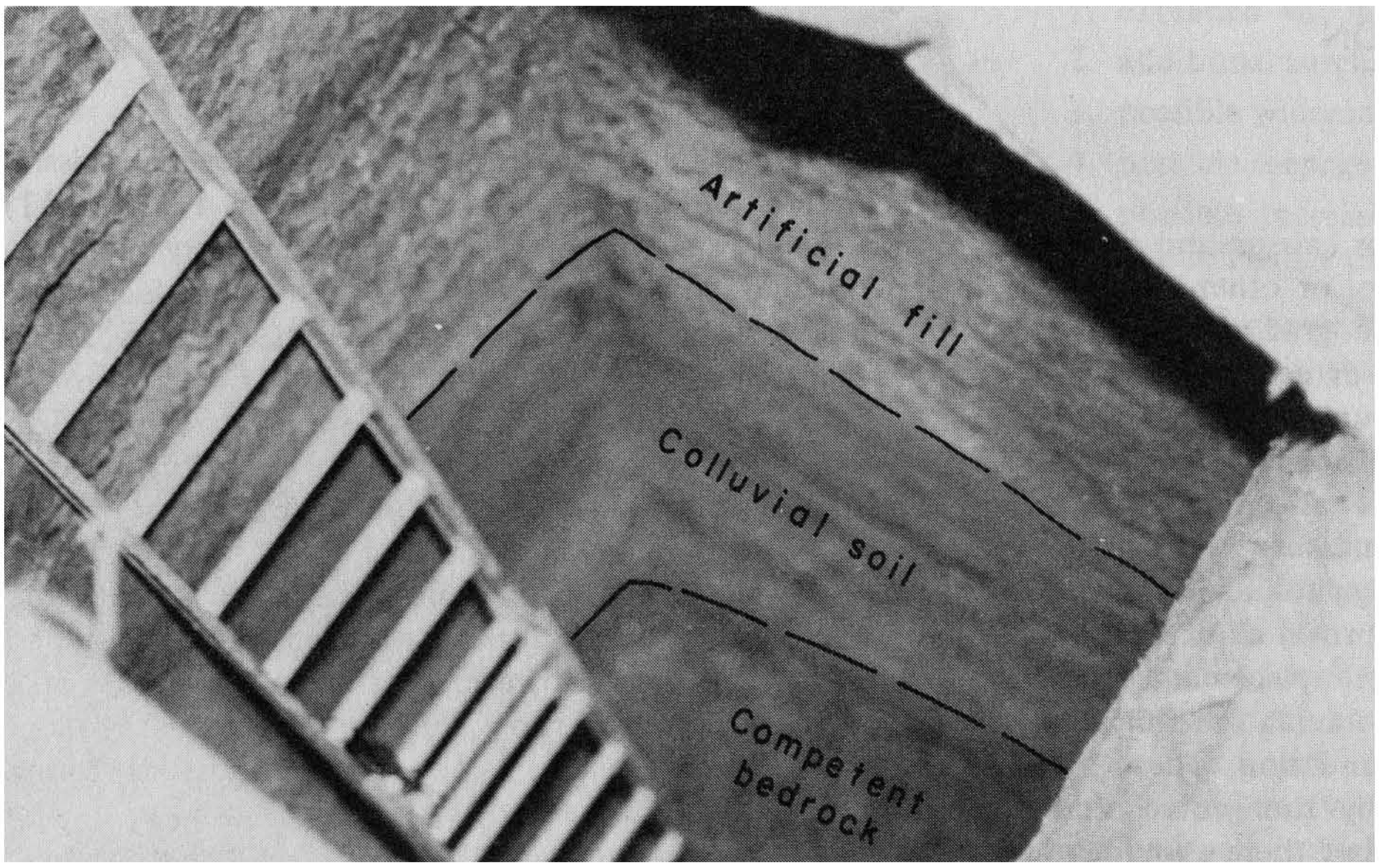
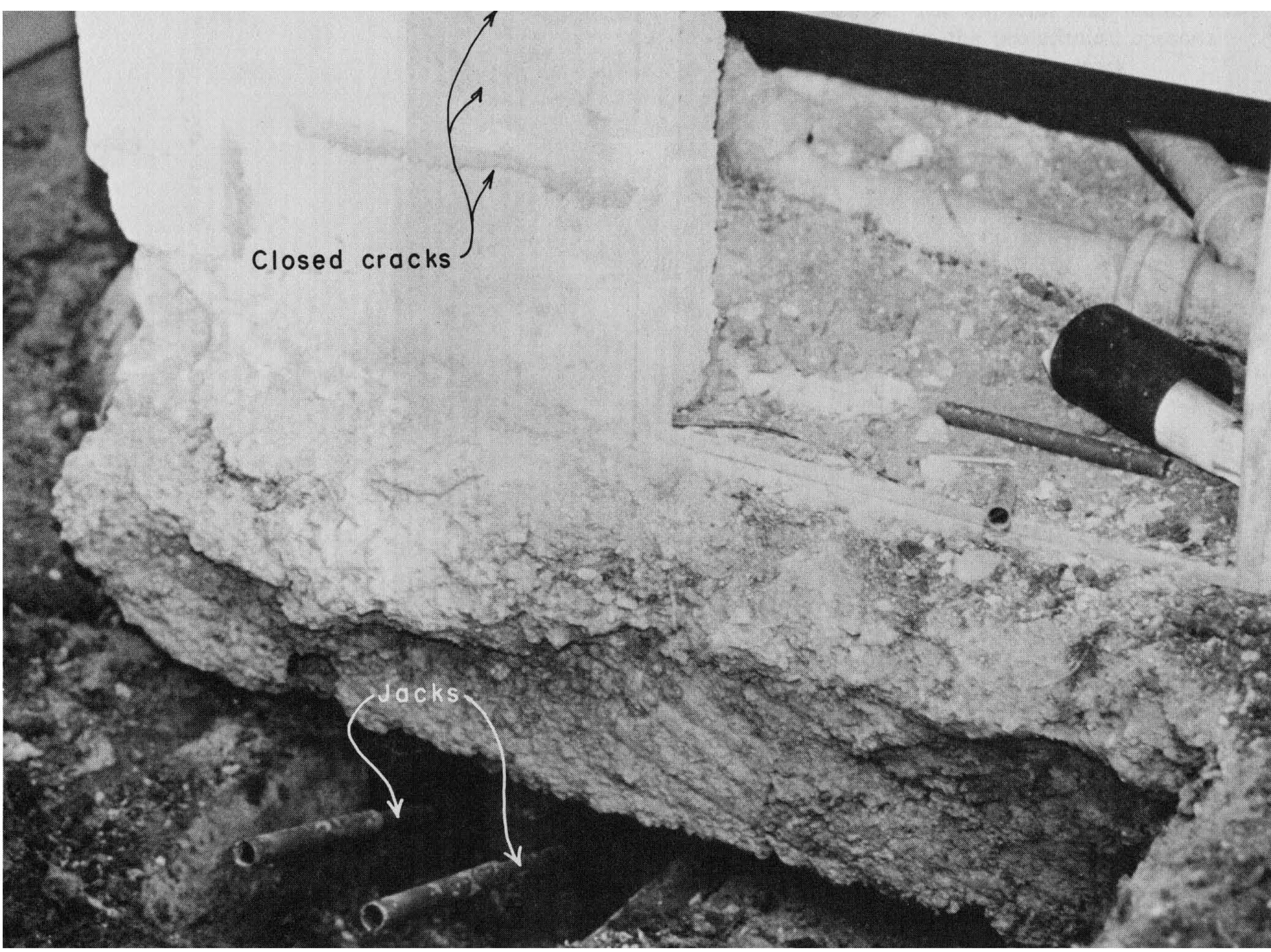


Figure 6-12 A hand-excavated caisson hole for underpinning the corner of a residence that was settling. This caisson was excavated to a depth of 20 feet, penetrating 18 feet of artificial fill and compressible colluvial soils and extending 2 feet into competent bedrock. Photograph by C. Michael Scullin.

Figure 6-13 Two 6-ton jacks rest on the caisson excavated in Figure 6-12. The foundations are jacked up into place, closing the settlement cracks at the corner of the residence. As jacks are removed, the opening is "mud packed" closed with cement. Photograph by C. Michael Scullin.

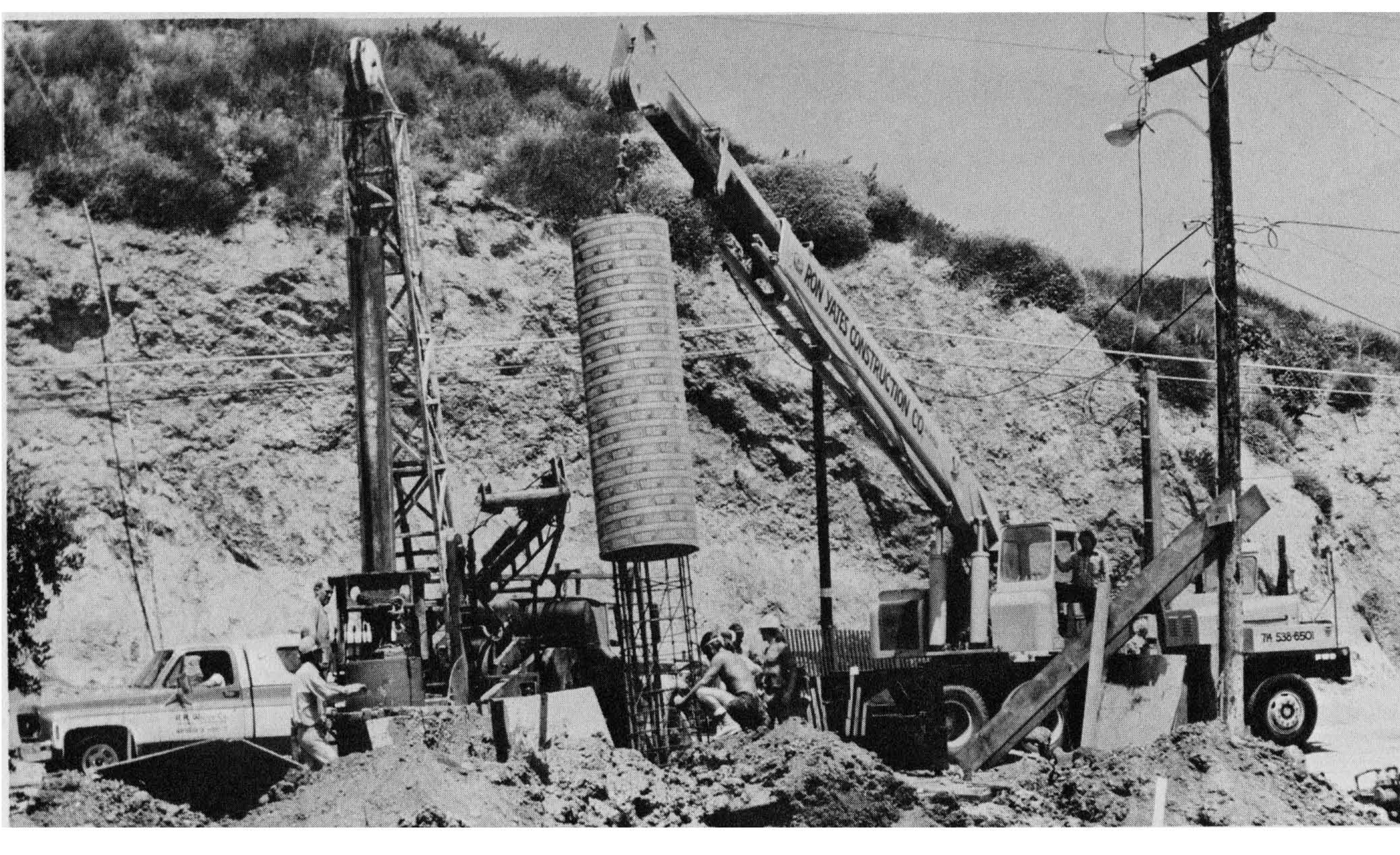


Beach-Front Cast-in-Place Construction

Figures 6-14 through 6-19 illustrate construction of a beach-front cast-in-place foundation. This is primarily an engineer-designed foundation where either the building or the grading inspector performs inspections. Such construction requires that the foundation be extended down into competent bedrock under the beach sand, and that the depth of penetration must be inspected and approved by the geotechnical personnel who designed it. This sequence of photographs illustrates the large amount of equipment and personnel required for coordination of the construction processes in such a project. It also shows a method of caisson and grade-beam construction other than that descending a slope. These structures are constructed above high tide line, and the foundations had to be designed so as to withstand the surging action of the ocean during high tides and high surf conditions.

Figure 6-14 Constructing beachfront cast-in-place foundations. The bucket-auger drill rig (right) is pulling away from a completed hole. The concrete truck (left) is carrying a friction-pile cage. A temporary sand-fill has been graded for a work surface. Photograph by and courtesy of Frank E. Denison, geologist.

Figure 6-15 Constructing a beachfront foundation. A hydrocrane (right) is lifting a friction-pile cage into place. The steel reinforcement case is shown in the hole with the sonotube placement. The drill rig (left) is using a short boom for work under the electrical wires. Overhead wires are potentially hazardous; drilling may be stopped or postponed until wires can be relocated. Photograph by and courtesy of Frank E. Denison, geologist.



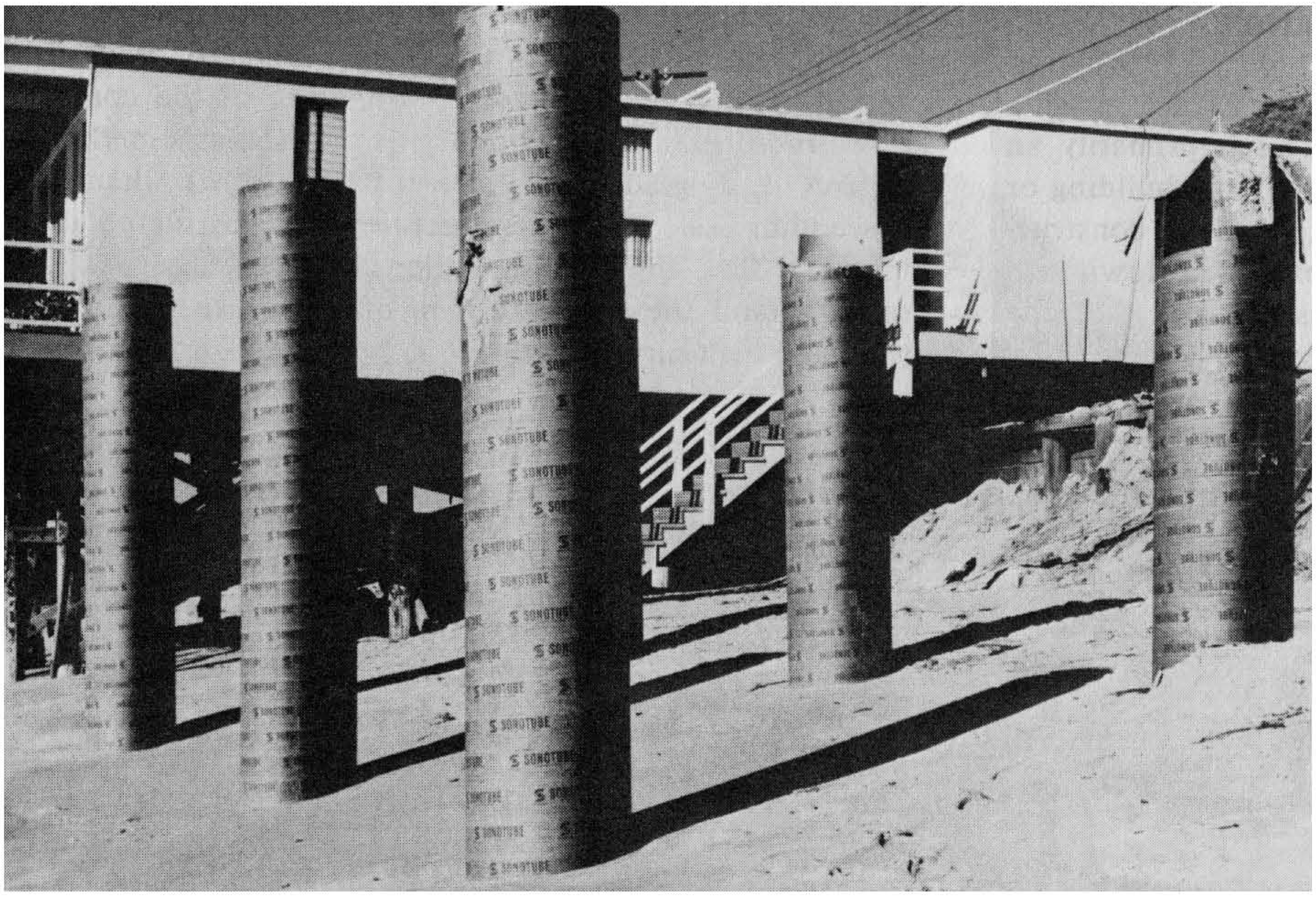
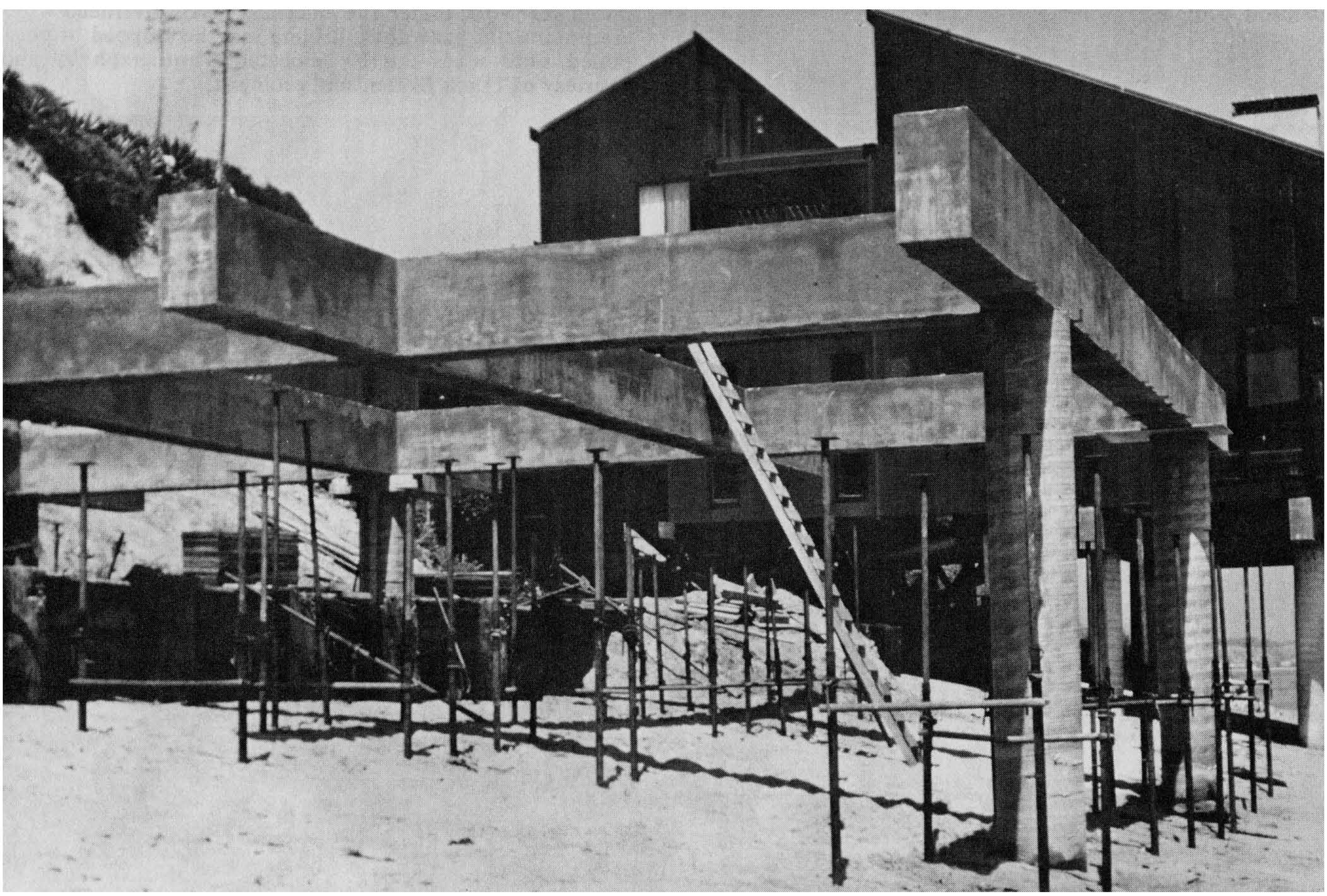


Figure 6-16 Constructing a beachfront foundation. Sonotube forms are used down-hole and also to extend caissons up to the required or finish-grade elevations. Foundations are extended down into underlying bedrock. Photograph by and courtesy of Frank E. Denison, geologist.

Figure 6-17 Caisson and grade-beam beachfront foundation. Note that these grade-beams are "tied" in two directions and sonotube forms have been removed. The rear bulkhead wall is completed on the street side of this residence. Photograph by and courtesy of Frank E. Denison, geologist.



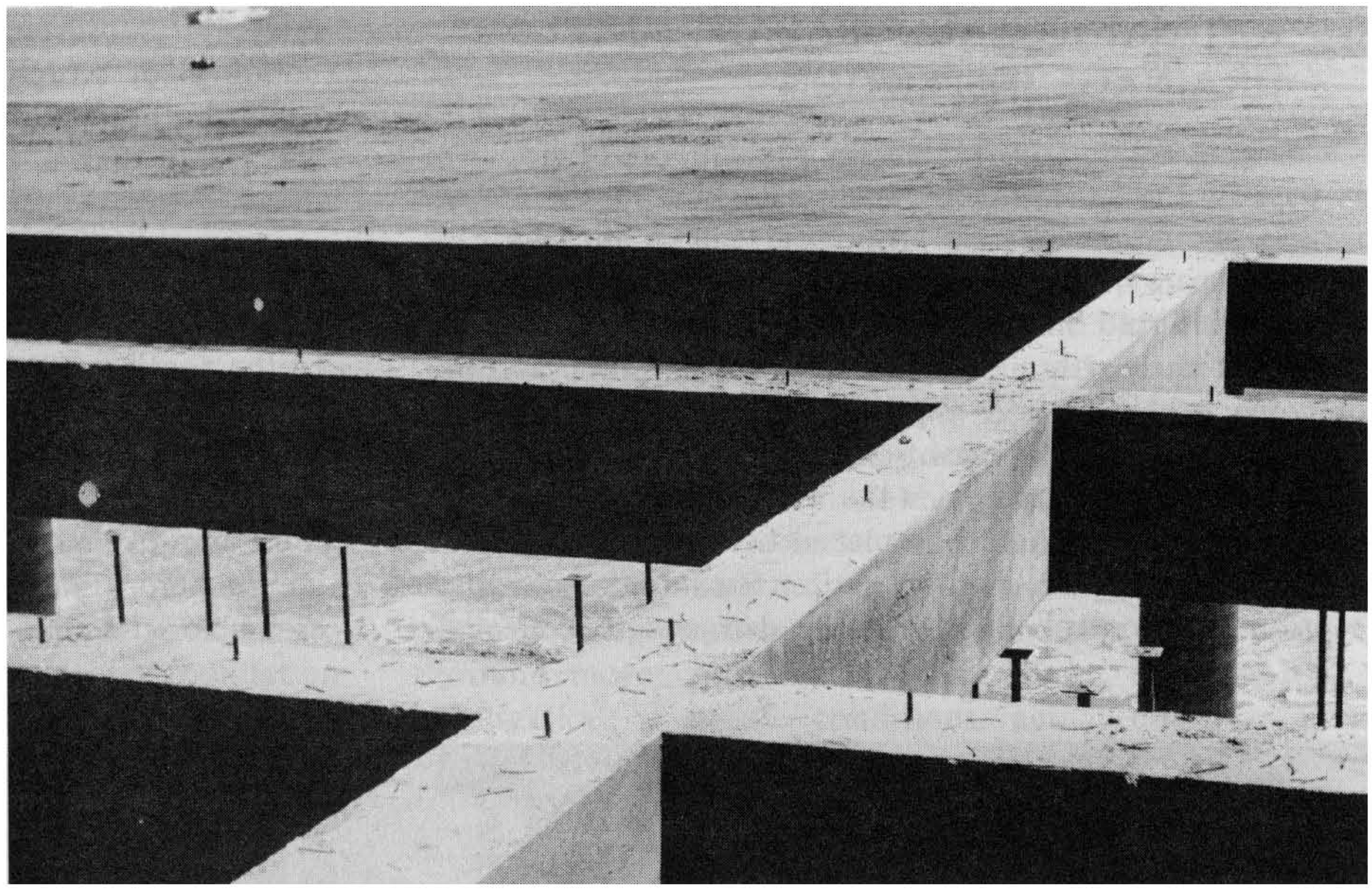
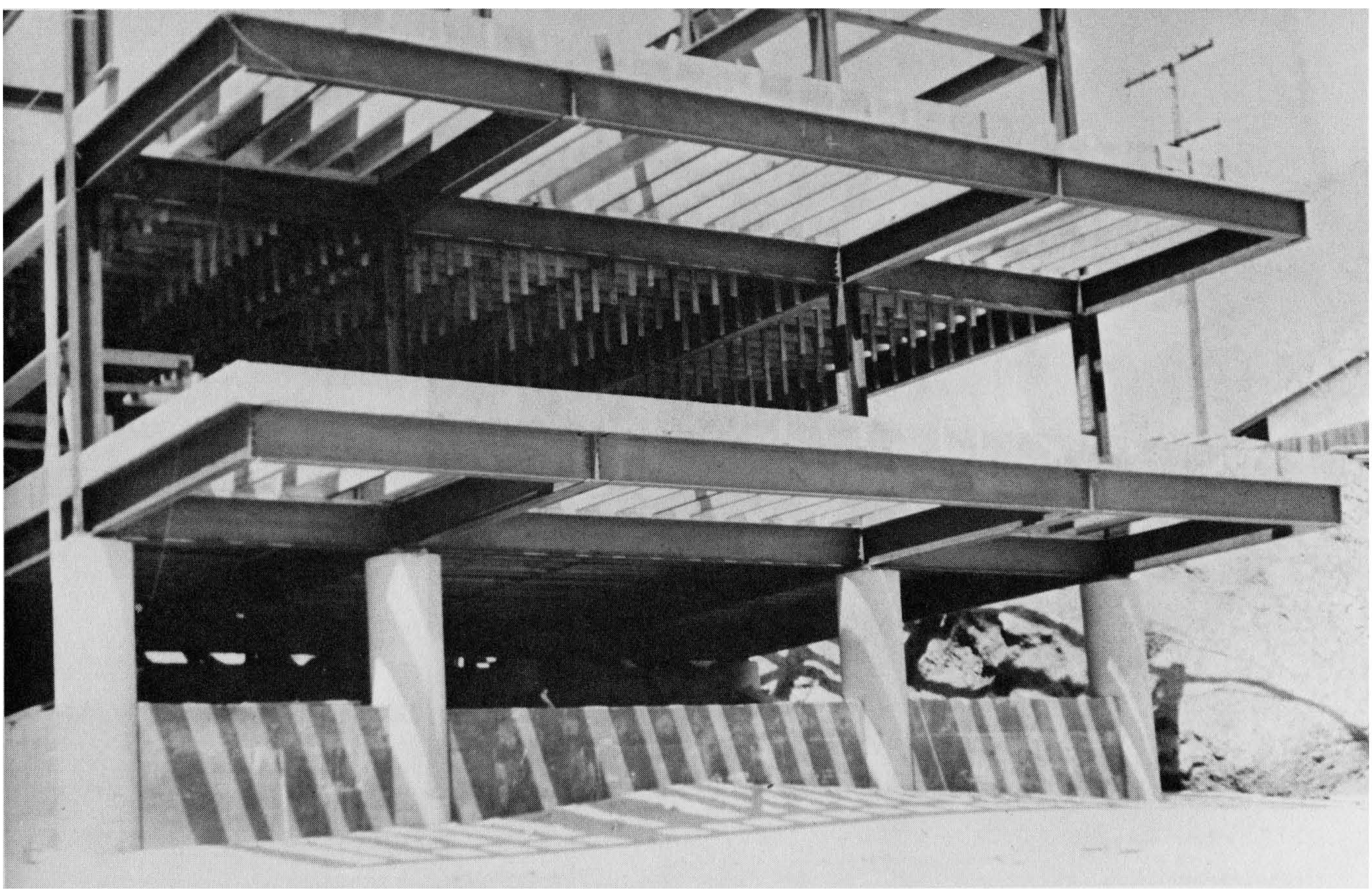


Figure 6-18 A close-up view of concrete grade-beams with tie-down bolts. Photograph by and courtesy of Frank E. Denison, geologist.

Figure 6-19 Residential construction on a beachfront foundation. Steel grade-beams are tied to cast-in-place concrete friction piles that extend into bedrock. Note that the bulkhead is tied to cast-in-place friction piles, and returns along the sides, thus acting as a seawall. Photograph by and courtesy of Frank E. Denison, geologist.



6-5 RETAINING WALL SEALANT AND DRAINAGE INSPECTION

Retaining walls, constructed for the support of slopes or as part of the subterranean portion of buildings and basements, should have some form of sealant and drainage design as part of the construction. The building or grading inspector should make sure that these walls are properly sealed on the earth side by means of a hot mop and felt or some other method approved by the design engineer. This is especially important at the location of the cold joint, or connection, between the wall and the footing.

Proper subdrains should be placed between the earth and the wall and provide a proper outlet for subdrainage interception and control. Subdrains are designed to collect or intercept subsurface seepage and direct it away from buildings or structures. This important construction step has often been neglected or improperly accomplished, with the result that a great deal of water damage to building interiors takes place each rainy season when moisture seeps through poorly sealed subterranean walls.

Figure 6-20 shows the hot mopping of the wall adjacent to the footing and lower portion of the wall. Felt or plastic is sometimes laid at the base with gravel overlying it. Perforated pipe should be laid with the perforations facing downward so that water runs off rapidly. When the perforations are facing upward, water must build up five or six inches before it gets into the pipe to drain, and silt can easily clog the pipe.

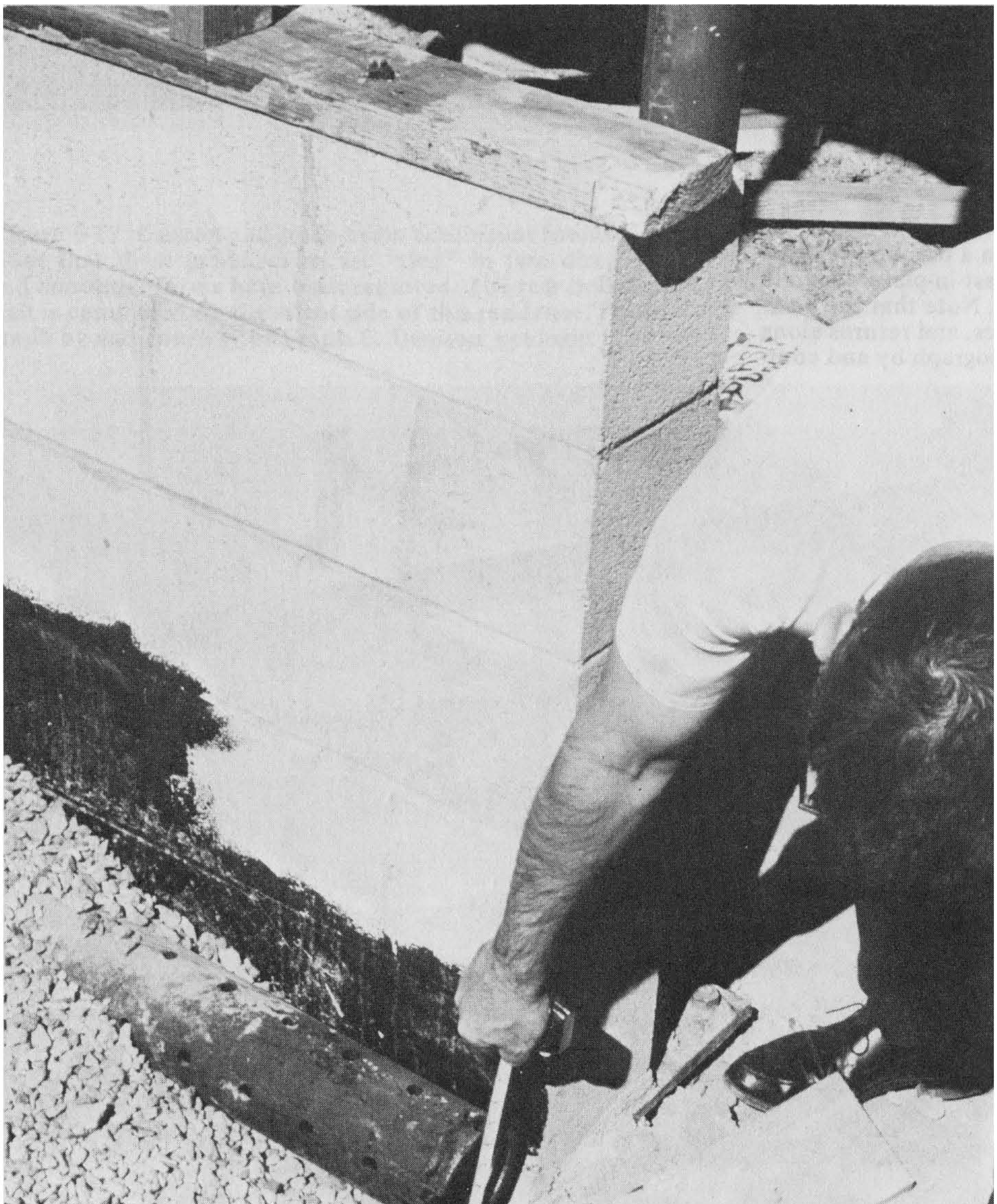


Figure 6-20 Subdrain along the sidewall of a residence. The wall and the cold joint between the wall and the footing must be sealed prior to placement of the subdrain. Subdrain pipe perforations should be faced *downward*. This photo shows the perforations up, which allows too much water to build up before draining and encourages siltation inside the pipe. Photograph by and courtesy of Alex Bruce, senior building inspector, City of Los Angeles.

Gravel backfill should provide at least two feet of "shading" (cover) to protect the pipe and to allow for a water buildup.

The top two feet of soil above the subdrain should be compacted and sealed off to prevent surface water infiltration into the subdrains since they are designed to intercept only subsurface seepage, not to perform surface drainage functions.

6-6 SPECIAL DRILLING

The following information is included to inform grading and building inspectors about the availability of numerous methods of underpinning structures and of getting into sites for the exploration necessary for engineered-foundation design and construction, and will avoid extensive technical details of drilling and subsurface exploration. We will describe some of the special drilling techniques used during house construction or during investigations for repairs due to settlement or landsliding, and some of the methods of soil improvement or underpinning of structures. Some of the common types of drilling equipment are the flight auger, the bucker auger, and iwan auger, churn drills, washboring drill rigs, rotary rigs, and percussion rigs. Figures 6-21 through 6-23 illustrate two of the portable hillside-type drill rigs that have increased the capability of subsurface exploration and caisson and grade-beam-type drilling.

There are special methods for drilling for caisson and grade-beam construction, soldier piles, bracing or anchoring, dewatering, tie-backs, and deadman purposes, for grouting either with cement or chemicals, and for establishing slope indicators or instrumentation for recording ground movements. Most of this drilling is either for investigation of unsafe conditions, actual construction of engineer-designed foundations, or corrective work in conjunction with settlement or slope failures.

Figure 6-21 An improved hillside bucket-auger drill rig, driven by hydraulic fluid, is lowered downhill by hand and leveled with a "third leg." The driller may add water to the cutting spoils to keep them from "running" out of the bucket. Photograph by and courtesy of Frank E. Denison, geologist.

Figure 6-22 (a) A boom-mounted hillside auger rig with 20-ft. hydraulic ram. The driller must change drill stems at each 15 ft. increase in depth. (b) A close-up view of the boom-mounted hillside auger with the operator at the controls. Two stabilization jacks provide support, and the Kelly bar is in the hole. Photographs by and courtesy of Frank E. Denison, geologist.

Horizontal Subdrains

The principal function of horizontal subdrains is to remove subsurface water from hillsides, cut slopes, and fill slopes. Horizontal drains are used in an effort to prevent slides by correcting the conditions that cause slides in slopes and embankments within certain types of soil or rock formations. They perform this function by removing the subsurface water either from a mass of sliding soil or from its source in an adjacent area. (See Figures 6-23 and 6-24.)

The removal of the subsurface water tends to produce a more stable condition in several ways. The seepage forces are reduced. These seepage forces are not necessarily in the direction of sliding, but, in general, may be far more detrimental than beneficial. The removal of the subsurface water tends to increase the shear strength of the soil. Cohesive soils that have a very high shear strength in a relatively dry state may have almost negligible shear strengths in a saturated condition. This is especially true of plastic (expansive) soils in fissures or in planes or joints that have been weakened by previous movement. Removal of the subsurface water reduces any excess hydrostatic pressures. Associated with excess hydrostatic pressures, there is a loss in normal forces, and hence a loss in frictional shear strength. Thus, a reduction in excess hydrostatic pressure causes a restoration or an increase in the frictional shear strength.

The depth to which the horizontal drains are made is controlled by several factors, primarily the depth to which the drains must extend to contact the water-bearing strata in order to drain the area properly and produce a stable condition. Other factors that control the depths are difficulty of drilling, quantity of water drained, the economy and effectiveness of a greater number of shorter drains compared with fewer but longer drains, and occasionally some other factors. Horizontal drains vary in depth from 50 to more than 300 feet, and are constructed between 100 and 200 feet in length. Frequently the gradient is about 10%.

The grading inspector should keep in mind that all of these types of drains should be designed by soil engineers and geologists. The purpose of horizontal and vertical drains must be established by these geotechnical personnel prior to the actual design and planning of the location. The second consideration by the grading and building inspectors is that the subdrains are placed and constructed under the supervision of the designing geotechnical personnel, and that upon completion of this construction, the outlets are tied into subdrains or improved drains in such a manner that their continued performance will not be jeopardized by other construction.

Figure 6-23 Drilling horizontal drains with a 2-in. diameter hollow-core drill stem and hydraulic ram. Water is used to advance the drill stem. Photograph by and courtesy of Frank E. Denison, geologist.

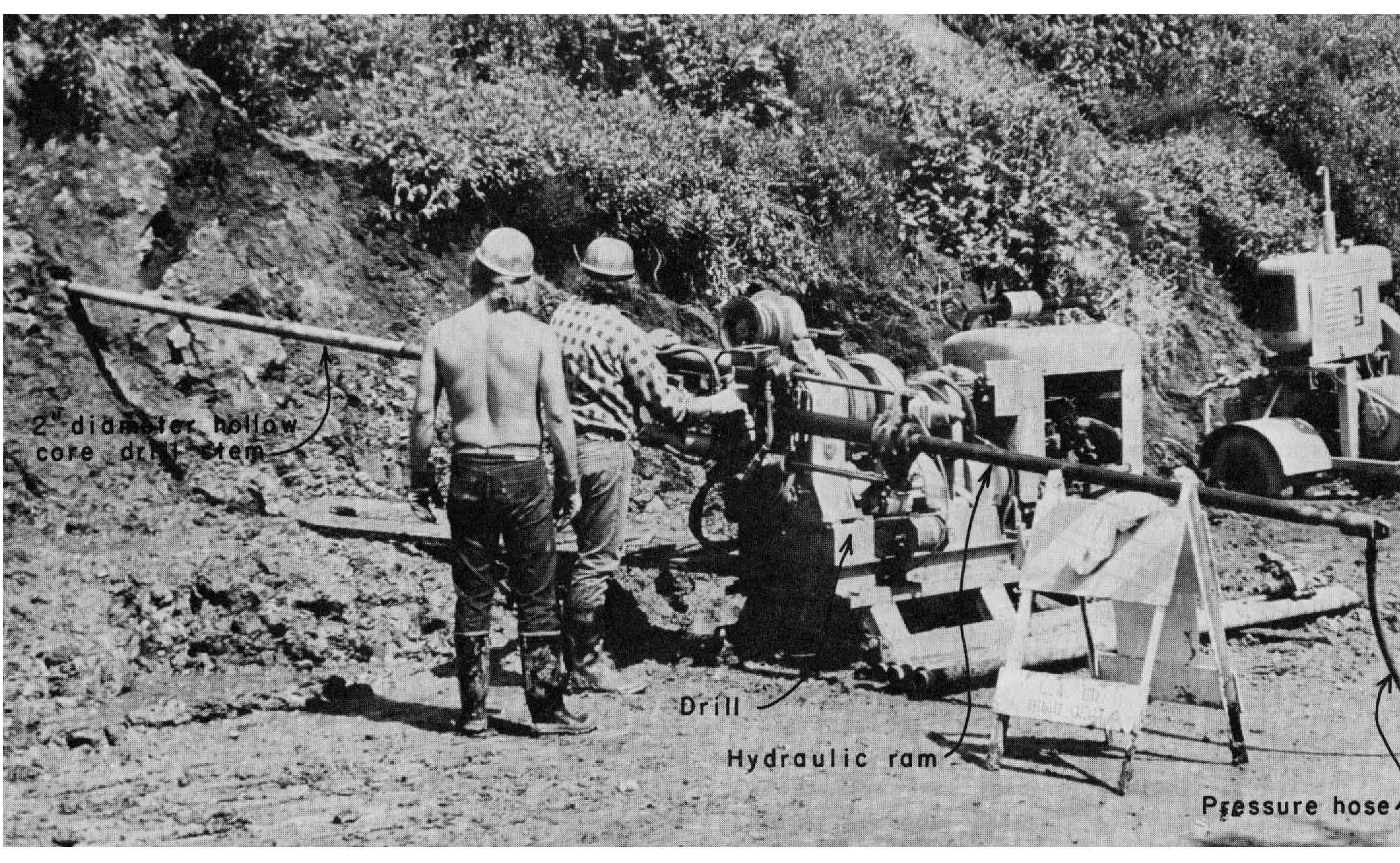
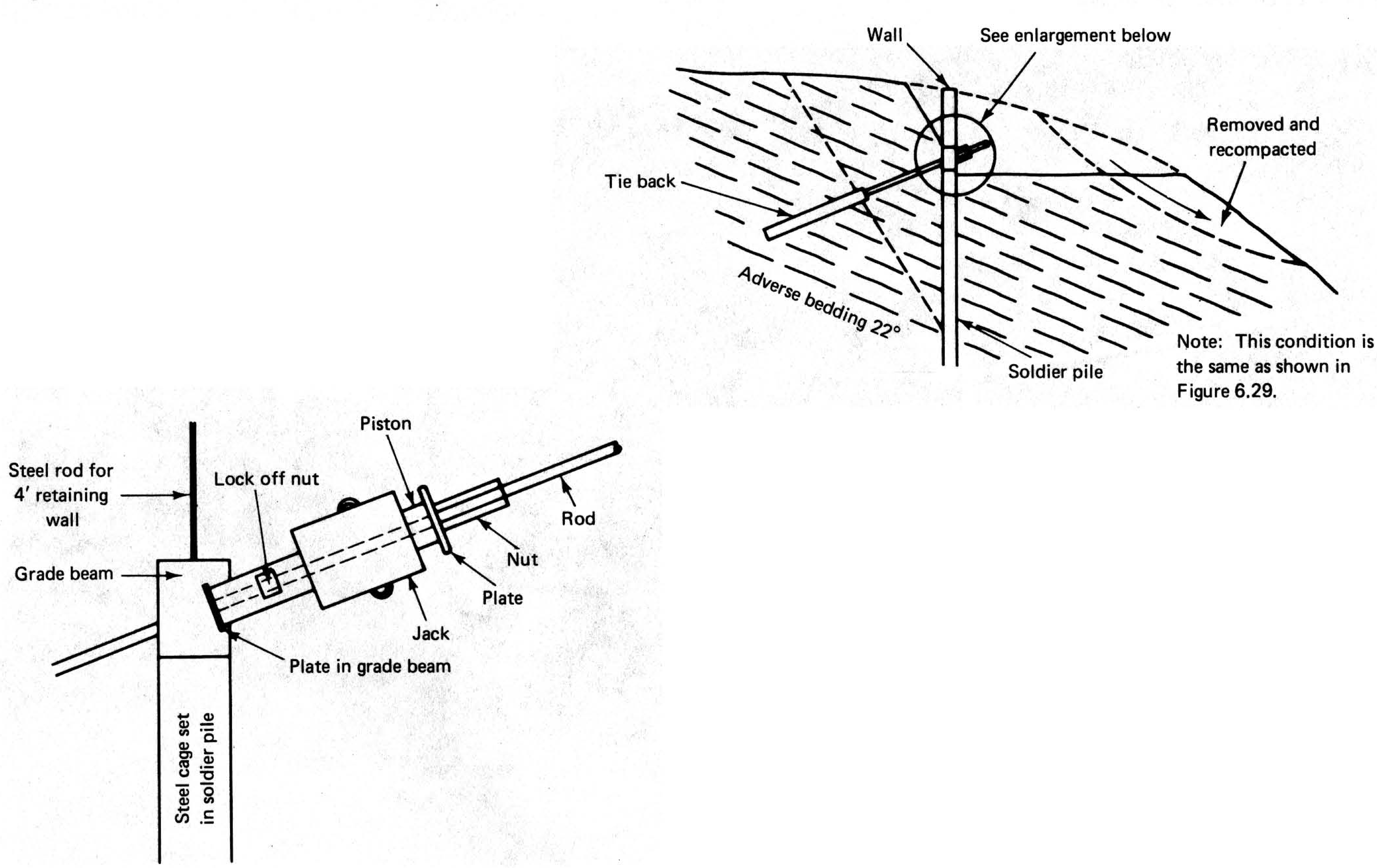


Figure 6-24 These horizontal subdrains are functioning as intended. The drain on the right is being drilled. Photograph by and courtesy of James E. Slosson.

Tie-Backs and Anchors

Tie-backs and anchors are normally engineer-designed drill-in anchors that extend down to and are fastened into bedrock. The drilled-in anchors can extend far back into the soil and take their resistance by friction between the soil and possibly a concrete cylinder or piling at the surface. They are often anchored to retaining walls, sheeting, or soldier piles. (See Figures 6-25 through 6-27.) The anchors are often used as tie-backs for large, excavated, near-vertical or $\frac{1}{2}$:1 excavated cut slopes in bedrock, or for shoring and bracing purposes. They are sometimes used for anchoring walls into the bedrock for lateral support purposes, and have been used as tie-backs for soldier beams or soldier piles in cases of smaller landslides.

Figure 6-25 Tie-back connection detail



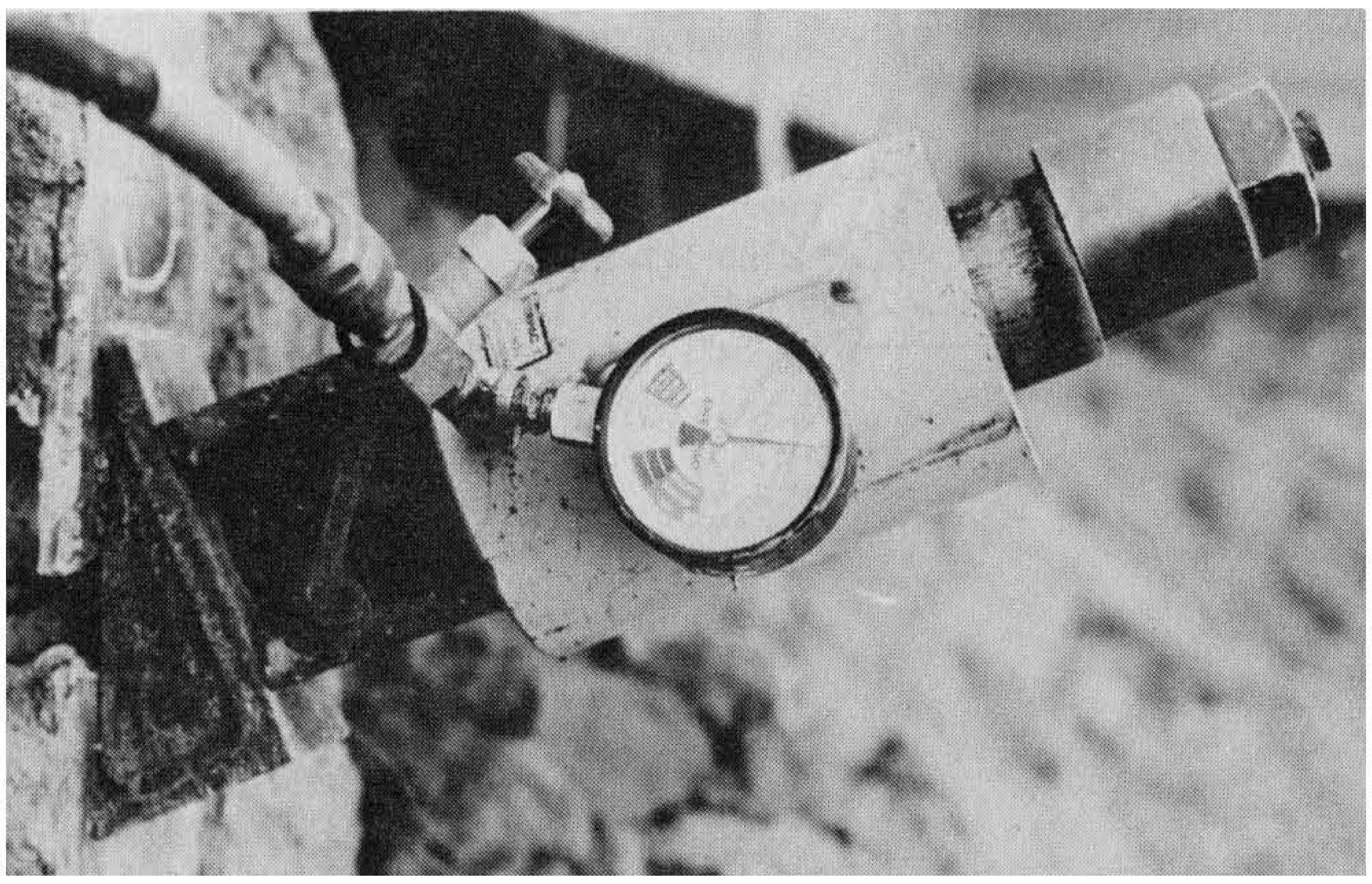


Figure 6-26 Tie-back setting with a $\frac{1}{2}$- to $\frac{3}{4}$-ton jack for tie-back set into an I-beam that is serving as a soldier pile. Photograph by and courtesy of Frank E. Denison, geologist.

Figure 6-27 Testing tie-backs and measuring movement between plate and jack. The tie-back is mounted on a vertical soldier pile and a horizontal grade beam. Note the gravel and steel above for a proposed 4-ft. high retaining wall. Photograph by and courtesy of Frank E. Denison, geologist.

Figures 6-25 through 6-27 illustrate tie-backs that are in the process of testing with gauges that are measuring the pressure exerted on the tie-backs. Anchor rods sometimes carry loads on the order of 30,000 to as much as 100,000 pounds. The most common loads are on the order of 50,000 pounds. The rods are usually one inch in diameter and made of a high-strength steel. The horizontal space between tie rods is usually 8 to 15 feet, and the vertical space between generally varies from 6 to 8 feet. The grading or building inspector should make sure that geotechnical personnel who have designed the tie-back system are represented on the site for deputy inspection and to assure that the work is being done in accordance with design specifications.

Slope Indicator Inclinometer

The slope indicator inclinometer is a precision instrument designed to aid civil engineers and geologists in investigating the performance of embankments and foundations, and monitoring earth movements in natural slopes. It is used chiefly in connection with landslides and other earth movements, land subsidence, earth and rock fill dams, piling and sheet piling, and retaining structures. Slope indicator inclinometers monitor:

1. the lateral displacement of earth and rock fill dams;
2. shear plane and direction of movements in landslides;
3. behavior of tie-back walls and bulkhead displacements resulting from loading;
4. pile behavior during horizontal load tests.

Figures 6-28 and 6-29 show drilling and placement of the downhole casing and the utilization of a slope indicator inclinometer. The following discussion of the digitilt inclinometer is provided by Delmar D. Yoakum, Chief Soil Engineer of GeoSoils, Inc., of Van Nuys, California.

The digitilt inclinometer system is used to measure lateral earth movement of dams, embankments, slopes, and landslides. Knowing the location and rate of lateral movement is critical to evaluating the performance and safety of structures in natural slopes. To determine subsurface movement, groove-casing is installed in a bore hole to a depth below the anticipated zone of movement. The grooves control the orientation (direction) of the sensor. The sensor is lowered down the casing and an initial set of readings is obtained at specified increments. (For example, two-foot intervals.) Periodic readings at these same depths provide data on the location, magnitude, direction, and rate of movement of the casing.

The digitilt system is designed to provide overall sensitivity of one part in 10,000 or ±.005 foot per 100 feet of casing. Using slope indicator company casing properly installed, the digitilt total system accuracy is .002 feet per 100 feet of casing.

The biaxial sensor Model 50320 has two servo accelerometers in a waterproof housing. One accelerometer has a sensing axis in the plane of the spring-loaded and fixed wheels that ride in the casing grooves. The second accelerometer has its sensing axis at 90 degrees to the first. The

Figure 6-28 (a) A crane is used to lift a truck-mounted bucket-auger drill rig into position to drill a slope. The rig is held in place by the crane during drilling. (b) The dewatering casing (white) and slope indicator casing are being hoisted into the drill hole. They are held in place vertically and backfilled with pea gravel for permanent use. Photographs by and courtesy of Delmar D. Yoakum, GeoSoils, Inc. (c) The slope indicator casing (dark) and dewatering casing (white) are shown in place and capped for future use. Photographs by and courtesy of Delmar D. Yoakum, GeoSoils, Inc.

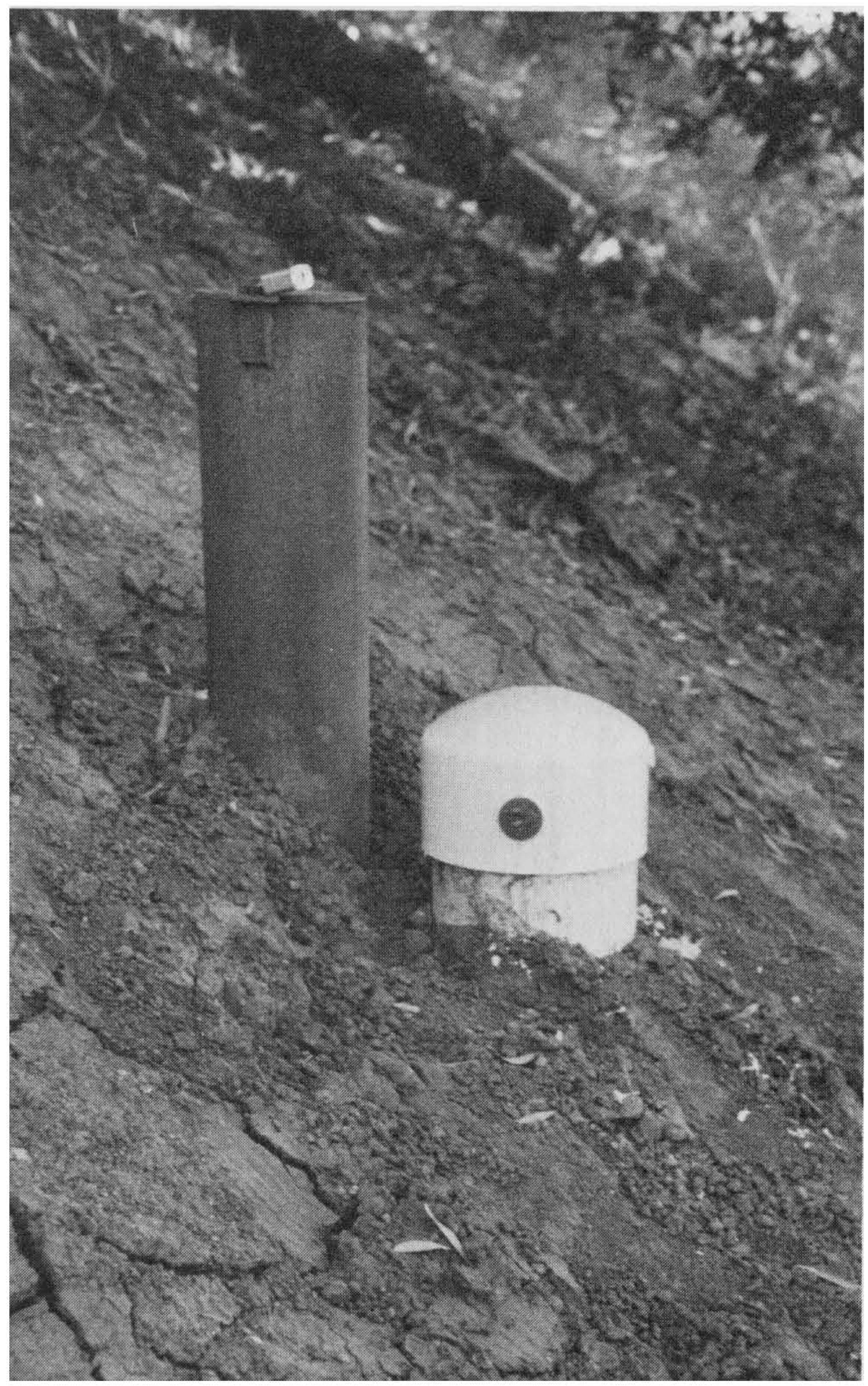


Figure 6-29 (a) Slope indicator inclinometer apparatus is shown, including the inclinometer sensor (foreground), the pulley assembly with cable hold (upper left), cable reel (upper center) and a portable field indicator (right). (b) Operation of the slope indicator inclinometer is shown. James L. Glaze, geologist (left), lowers the sensor with the pulley assembly as Delmar D. Yoakum, soil engineer, reads and records the field data. Photographs by and courtesy of Delmar D. Yoakum, GeoSoils, Inc.

accelerometers are energized by applied voltage from the indicator and provide a rapid stabilized response to tilt by changing the current flow through the circuitry. The resulting voltage output is proportional to the sine of the angle of inclination from the vertical position. The output voltage is stable with respect to temperature, input voltage variations, and land resistance. The standard digitilt system will operate through ±30 degrees from the vertical. Using optional 1.0g accelerometers, this range may be expanded to ±90 degrees. The standard Model 50320 is designed to operate in a casing of about $3\frac{1}{2}$ inches o.d. A small diameter, 1-inch, digitilt sensor is available in biaxial and uniaxial models.

The readout indicator is designed for portable field use. The indicator has an illuminated digital display and automatic polarity (direction) indicator for each reading in the field. The portable indicators operate on rechargeable batteries or on an external 12-volt battery. Portable indicators are also available that provide teletype interface output or internal magnetic cartridge recording.

The sensor is connected to a readout indicator with a specially designed multiconductor electrical cable with a stranded steel core. The cable is jacketed with heavy waterproof neospreen marked externally at one-foot intervals for easy depth determination.

The function of the slope indicator is to detect the inclination of the casing from the vertical. By taking readings at regular depth intervals inside the casing, the profile of the casing can be constructed. Repeating such measurements periodically provides data on the location, magnitude, direction, and rate of movement of the casing. The differences in successive readings at identical depths represent a change in inclination which is converted to linear displacement. A progressive change of readings indicates a zone of movement.

The digitilt inclinometer system is one of many downhole instrumentations used in determining lateral earth movements, water levels, and water pressure. The brief discussion in this subsection is included primarily to inform building officials of sensitive instrumentation available to geotechnical personnel for compiling data regarding subsurface ground motion conditions. Figures 6-28 through 6-29 show slope failure detection in a residential subdivision. In this case, the instruments are used to define the depth of landslide and rate of movement so that geotechnical personnel can design a safe support structure to prevent further movement.

6-7 COMPACTION AND CHEMICAL GROUTING

Compaction Grouting

The injection of soil-cement to displace and compact soils has become a relatively important part of soil stabilization. It is more frequently used to repair buildings damaged by settlement, to underpin foundations, to increase the strength of underlying supporting soils, and to raise buildings back to their normal level position. Settlement of foundations or floor slabs may be substantial because of relatively low densities of soils underlying the site. Common low-density characteristics include: (1) low bearing value, (2) settlement under load, (3) additional settlement with substantial increase in moisture content, (4) additional settlement when subjected to vibration or loading such as by an earthquake, and (5) potential for liquefaction soil instability in cases of extreme earthquake shocks applied to low-density saturated sand.

The following abstract is written by Mr. Jack Eagen, Vice President, Moore & Taber Grouting, Anaheim, California:

Compaction grouting is a relatively new but proven method for treating compressible foundation soils in-situ (in place) and correcting structure distress due to settlement. Practical techniques are available to effectively stabilize soils undergoing consolidation and secondarily lift the overlying ground surface along with any supported structures. The process differs from conventional penetration grouting by its use of a very stiff, sand-cement mix that results in a homogeneous mass when emplaced. Densification of the soils is accomplished by pressure displacement and compression rather than permeation of the intergranular voids. The grout tends to move into the weakest soil zone until a force exerted by the pumping pressure exceeds the confining conditions and movement of the ground surface occurs.

Advantages of compaction grouting over conventional remedial measures are minimum site disturbance, economy, flexibility, treatment of some saturated soils, and simultaneous stabilization and lift. Disadvantages or limitations are due primarily to reduced effectiveness at very shallow depth or where insufficient lateral restraint is available and, in some cases, to the cost of treating very large areas or very deep-seated problems.

Detailed records are kept of the grout procedures including injection intervals, pressures, implaced volumes, and surface movement. These data are combined with previous investigative information to determine the proper pumping sequence and depth to accomplish maximum soil stabilization and lift, and to adjust the grouting to accommodate the various conditions encountered. The grouting data are analyzed to determine the results of the work, such as increased density, structure lift, and ground movement.

Figures 6-30 through 6-33 are illustrations of compaction grouting supplied by Moore & Taber Grouting of Anaheim, California. These photographs show compaction grouting procedures of Juvenile Hall, Sylmar, California, which had been extensively damaged due to liquefaction during the 1971 San Fernando earthquake. The buildings were stabilized through the use of compaction grouting.

Edward D. Graf of Pressure Grout Company of South San Francisco, California [1] has provided the following information about compaction grouting.

Observations of both successful and unsuccessful jobs in a wide variety of structural problems and soils problems, together with analysis of the variations and the results, have produced the following conclusions:

1. Compaction grout does effectively compact most man-made fills ranging from garbage dumps to inadequately compacted grading fills.
2. Compaction grout does effectively compact organic top soil not stripped out below an engineered fill, whether that top soil is a few inches or a few feet thick.
3. Compaction grout does effectively compact sands under most conditions. Silty sands and clayey sands can be readily compacted. Clean sands can be more effectively compacted or stabilized by means of vibration or chemical grout; however, it may be adequate and economic to use the compaction grout technique under many circumstances.
4. Silts can be effectively compacted by means of compaction grout. Even low-density silts below the water table have been compacted by this method with the additional technique of providing a time interval to allow the silts to drain under the grout and soil pressures between successive bulb injections.
5. Saturated clays cannot be consolidated by the compaction grout technique. Unsaturated clays can be compacted with the proper technique. Lenses or strata of compressible materials within masses of saturated clays, such as San Francisco "bay mud," have been effectively compacted to prevent differential settlement.
6. Peats have been successfully compacted by means of compaction grout. However, peats are often in a marginal area because of saturated clay content.
7. Compaction grout is not normally effective in the near surface 2 feet to 4 feet because the reaction, or confining, pressure for the grout is the weight of the cone of soil above it. When confined by a structure or other superimposed loads, compaction grout can be effective near the surface.

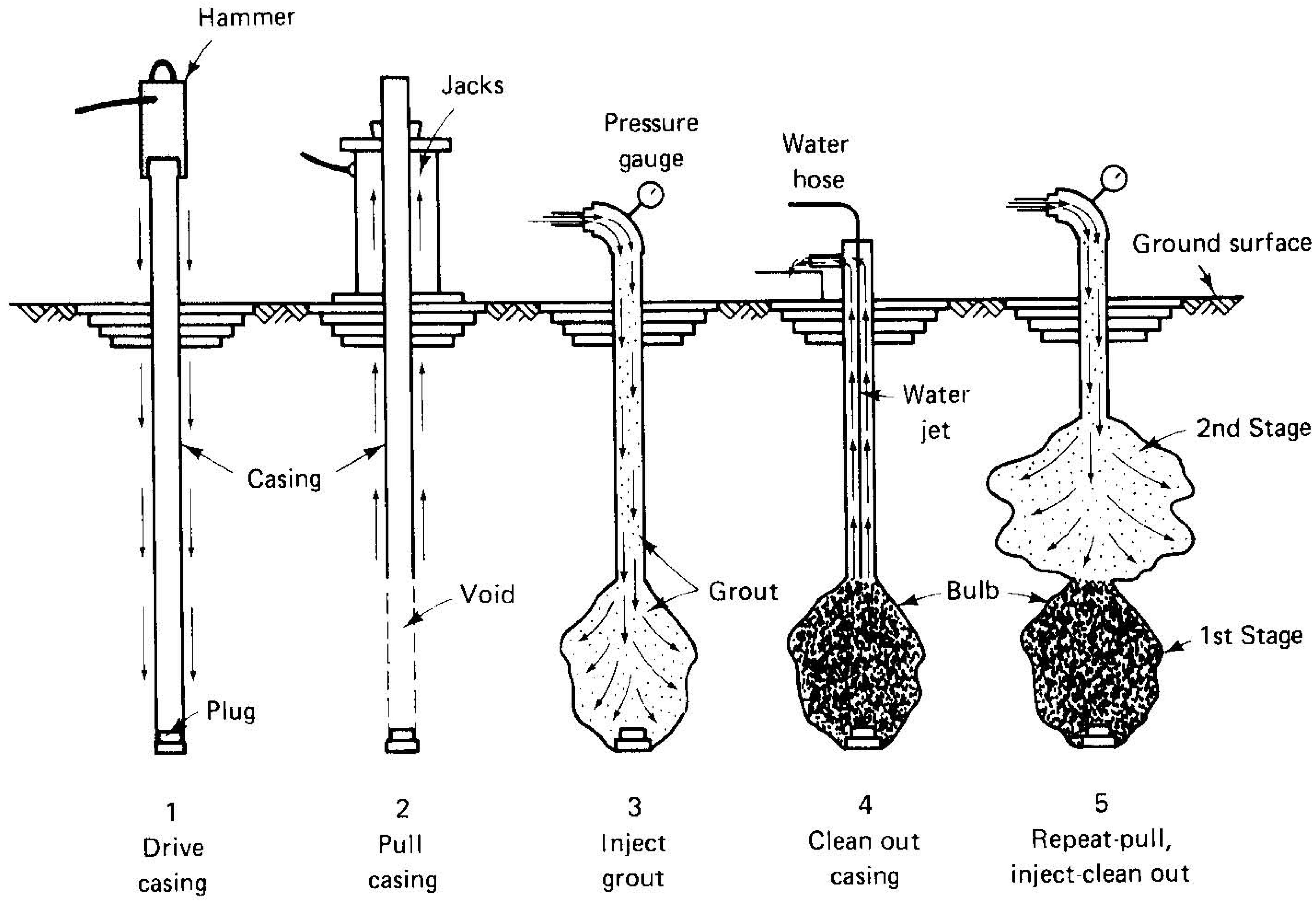
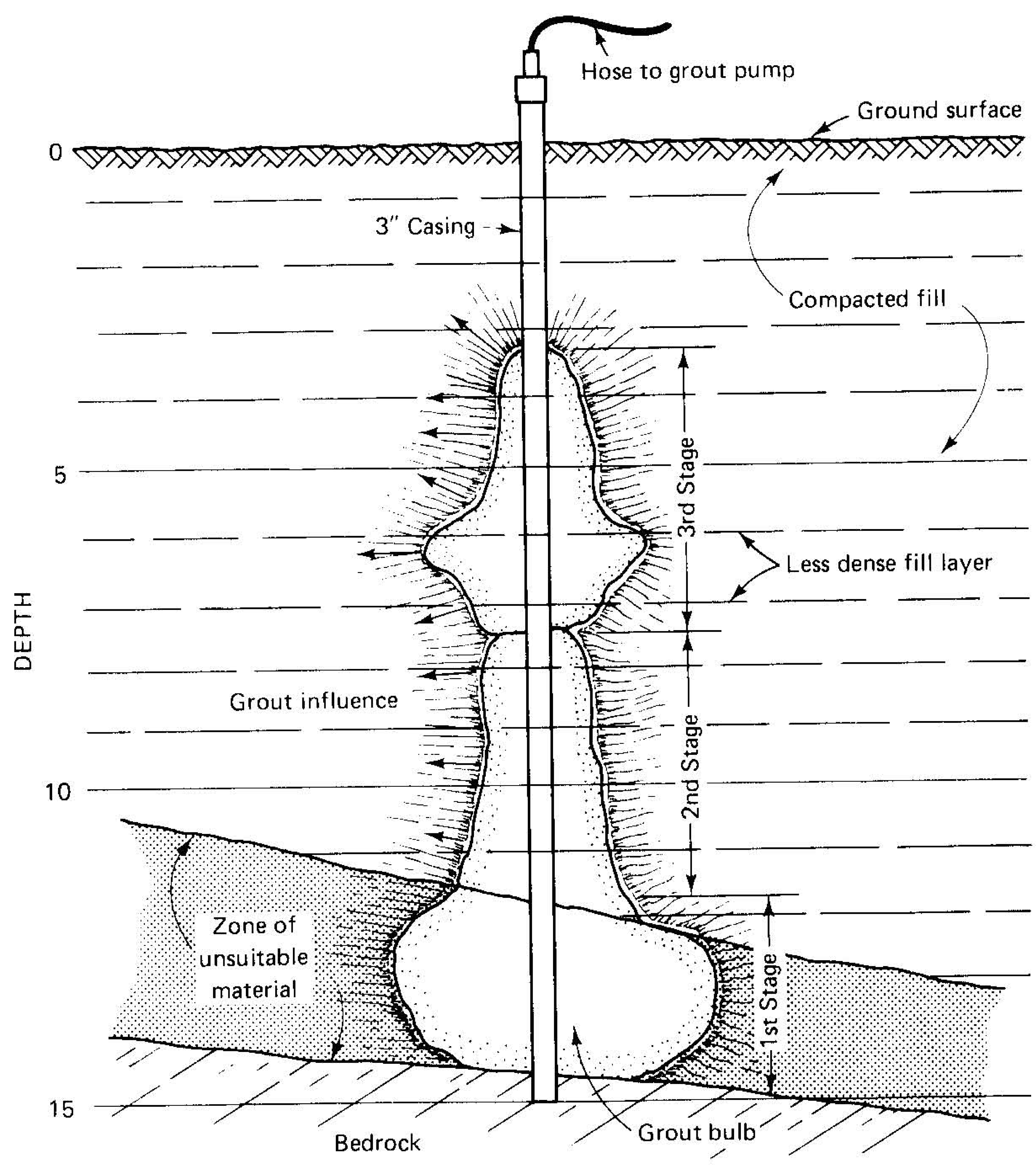


Figure 6-30 Stage grouting sequence

Source: Moore & Taber

Figure 6-31 Compaction grouting column



Source: Moore & Taber

Figure 6-32 (a) Compaction grouting pump, mixer, and sand hopper. An end-loader (behind) waits to dump more sand into the hopper. Two drillers (right background) drive casing with a portable air hammer. (b) Driving a casing using a portable air-driven hammer for compaction grouting. Photographs by the Los Angeles County Dept. of the County Engineer-Facilities Photographic Unit, courtesy of Jack Eagen, Moore & Taber, Anaheim, CA.

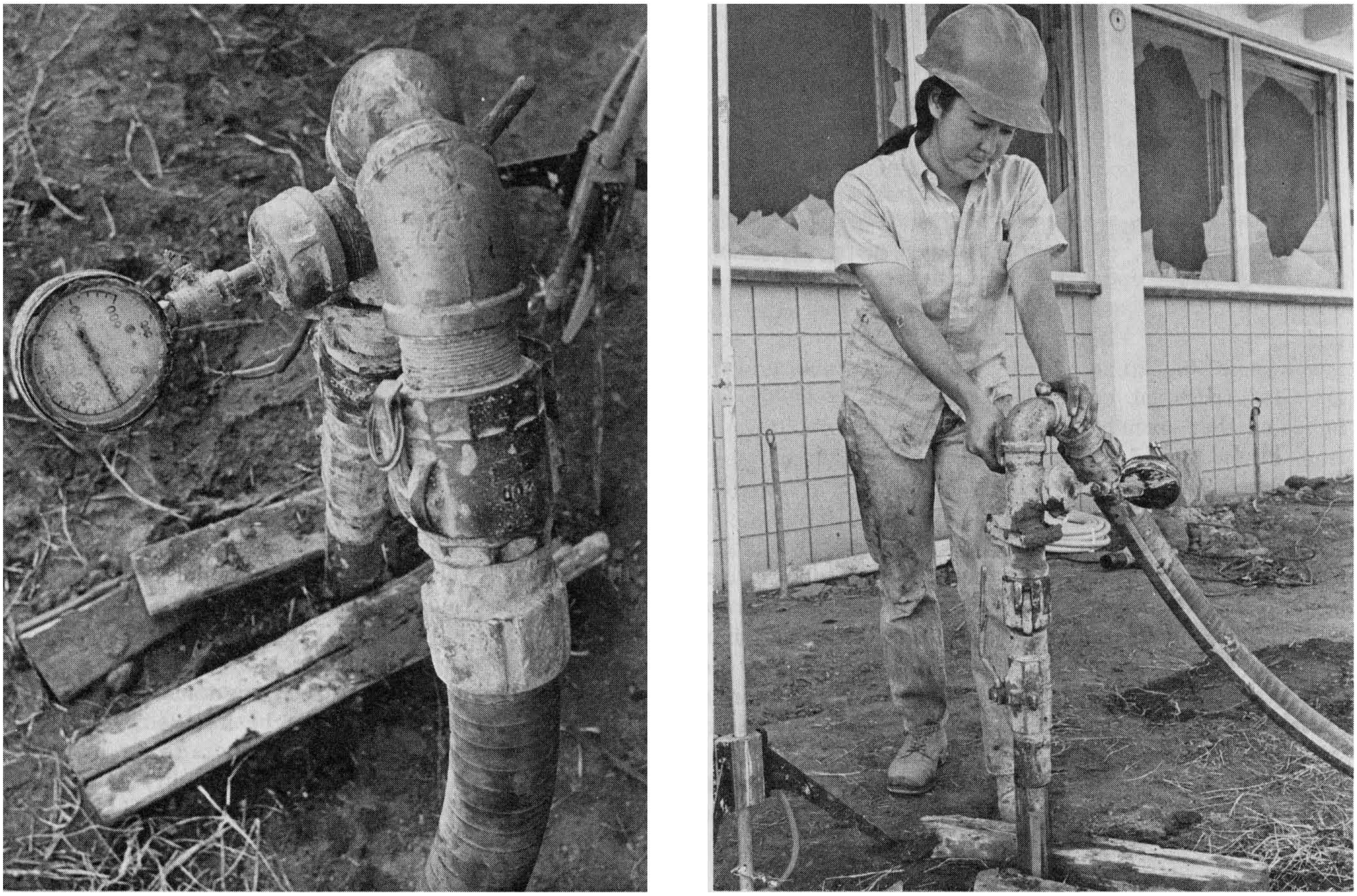


Figure 6-33 (a) A grout injection point with pressure gage is shown. (b) Pumping with a manometer at the front injection point to record ground movement. Photographs by the Los Angeles County Dept. of the County Engineer-Facilities Photographic Unit, courtesy of Jack Eagen, Moore & Taber, Anaheim, CA.

8. Under some conditions, large additional loads imposed after compaction grout will result in settlement. This is not normally true when the compaction is done at depth. The settlement that will take place will only be a fraction of what would have taken place without the pregrouting.

9. The compaction grout technique can be safely and economically used for lifting almost any light structure under almost any soil condition. Heavy structures can be lifted with a high degree of control under favorable conditions.

10. The bulb spacing for effective compaction of any soil is, currently, a factor of experienced judgment based on depth of bulb, nature of soil, quantity of grout "take" at each bulb, and the engineering function of the compaction.

11. Shallow injection pipes should normally be driven or dry-drilled into place in order to provide frictional resistance against pipe "pump out" and to seal the grout bulb.

12. Compaction grout can be safely used adjacent to filled slopes. However, adequate and continuing measurements must be maintained during the grout operation to preclude causing a slope failure.

13. Adequate observation of an area around the injection point, varying with the depth of injection, must be maintained because of occasional shearing resulting in lift at an undesirable point.

14. Pressure and volume observations are necessary criteria to aid an experienced foreman. Due to the wide range of problems that arise, there is no substitute for an experienced foreman working with an experienced engineer.

Chemical Grouting for Soil Solidification

Chemical grouting for soil solidification is used for the following applications:

1. to increase the load-bearing capacity of soil formations, such as under walls and footings;
2. to make porous soils impermeable to water;

3. to prevent flooding of basements, subterranean structures, mines, shafts, and tunnels;
4. to prevent water seepage through dams;
5. to seal porous concrete, block, or brick work—as in airport, highway, sewers, or subway construction—or subterranean concrete or masonry structures.

Chemical grout is a pure solution without any particles in suspension, and, as a solution, it will permeate a sand mass. Depending upon the chemical system used, it will change the sand mass into a solid that has cohesion. The end product is a sandstone that will vary from a soft friable sandstone to an extremely hard sandstone. Edward D. Graf (personal communication, January 1980) has indicated that chemically grouted sands may obtain variations in unconfined strengths ranging from 2000 psf up to 75,000 psf. The primary variables are the chemical system and the concentrations used for each site.

The PQ Corporation of Valley Forge, Pennsylvania [2] has indicated that certain of its liquid sodium silicates can be used in a one-shot process for soil solidification. Properly combined with formamide and either cement, calcium chloride, sodium aluminate, or sodium bicarbonate, the sodium silicate forms a gel that increases the load-bearing strength of soil and stabilizes it against intrusion by water, vibrations from heavy machinery, or erosion.

The PQ Corporation further indicates that the sodium silicate/formamide system for soil stabilization does the following:

1. gives a uniform grout;
2. is permanent in freeze-thaw cycles;
3. resists frost heaving;
4. resists mild acidity, salinity, and bacteria;
5. is ecologically safe.

The silicate-based grouts have major advantages over cement grouts and acrylamide-based grouts. Because it is in a liquid form, silicate grout can penetrate finer voids than cement and does not settle out as does a cement suspension. In addition, silicate grouts can be adjusted to set in minutes, whereas cement requires two hours for initial set. Silicate-based grouts provide greater load-bearing capabilities than acrylamide grouts, which remain plastic after setting. Consequently, they are restricted to low load-bearing applications. Additionally, silicate-based grouts are more ecologically acceptable than acrylamide.

Chemical grouting and compaction grouting are functions of specialty contractors. The criteria for chemical groutability for underpinning of foundations in sand is based upon grain sizes up to 15% passing the 200 sieve and based upon 100% passing the $\frac{1}{4}''$ sieve. Variation of 15% to 20% passing the 200 sieve is within a gray zone of approval, whereas over 20% is unsatisfactory for shallow work. Under deep conditions, sands with grains over 30% passing the 200 sieve have been successfully grouted. The experience of the specialty contractor is the key to determining the type and quantity of grout mix needed because of the tremendous variations in soil structure and composition, and the variable soil environments. The degree of stabilization needed is generally determined by the chemical properties, density, water content, and distribution of grain size in the soil. Because of these variables, each site has to be evaluated on its own merits, so the grout mix and gel times may be designed for the conditions of the site.

The best placement of grout is achieved by injecting it under pressure through open-ended pipes or "needles." These are driven, in a predetermined grid pattern, into the soil, or through inserts set into well bores drilled into rock or concrete.

In addition to the use of chemical grouts for improving sandy soils, soil chemists have been developing methods of chemically stabilizing clay masses by using kinetic energy and improving the engineering characteristics of the clay. Ion Tech, Inc., of South San Francisco, California [3] has developed a method to minimize, or, in some cases, effectively stop, landsliding through ion diffusion along the slide plane, substantially strengthening the zone along the slip surface. Where structures requiring high factors of safety are involved, the Ion Tech Method is not a complete answer, but is an additional tool. A conservative engineer will use the treatment as a quick and inexpensive measure to help stabilize a slide until conventional corrective measures, such as buttresses, may be installed. In all cases, improved drainage is a prudent measure to use in addition to the Ion Tech treatment. The probability of success of the Ion Tech Method is based upon the mechanics of the slide, the factor of safety, proper sampling for laboratory analysis, adequate laboratory results, and the possibility of contacting the slip surface with the proper ionic solution.

Chemical grouting has become an increasingly useful tool in improving soil conditions involving many types of construction. No doubt specialty contractors and soil chemists, in coordination with geotechnical consultants, will develop new applications of this valuable technique, which improves soil stability to provide safe building sites.

6-8 SEA WALL INSPECTIONS

Many miles of coastline within the United States are developed for residential construction that, in many cases, requires some form of protection by sea walls or riprap construction. Many of the sea walls built for private property are not constructed properly to provide the best safety conditions for the residence. The large sea walls built by the United States Army Corps of Engineers or by other government agencies are usually based on extensive studies of the coastal processes and are normally properly designed to provide safety on that coastline. On private property, because of limited area, limited size, and limited design criteria data, the sea walls are often not designed to handle erosive conditions caused by the high-surf/high-tide conditions. Figures 6-34 through 6-40 illustrate the closeness of structure to the high-tide lines and the erosiveness of the ocean. In contrast, Figures 6-39 and 6-40 show a major reinforced concrete structure that was developed for a

Figure 6-34 Beachfront homes in Southern California with high-tide surf surging beneath. These residences are set on pilings without seawalls or bulkhead protection on the seaward side. Photograph by Mark Malone, courtesy of Kovacs-Byer and Associates, Inc., soil engineers and geologists, Studio City, CA.

Figure 6-35 Beachfront homes with high-tide surf encroaching beneath. Photograph by and courtesy of Robert W. Ross.

Figure 6-36 Pacific surf is shown pounding and destroying a recently completed wood plank bulkhead which lacked backfill and provided little resistance to the lateral force loads exerted by the ocean. This builder gambled and lost. Photograph by and courtesy of Frank E. Denison, geologist.

Figure 6-37 This seawall return does not extend back into the lot far enough. A high-sea, high-surf combination has surged the sand out from behind the wall. If the condition is not corrected immediately, this will become a standing wall that can be knocked down by subsequent waves. Photograph by and courtesy of Robert W. Ross.

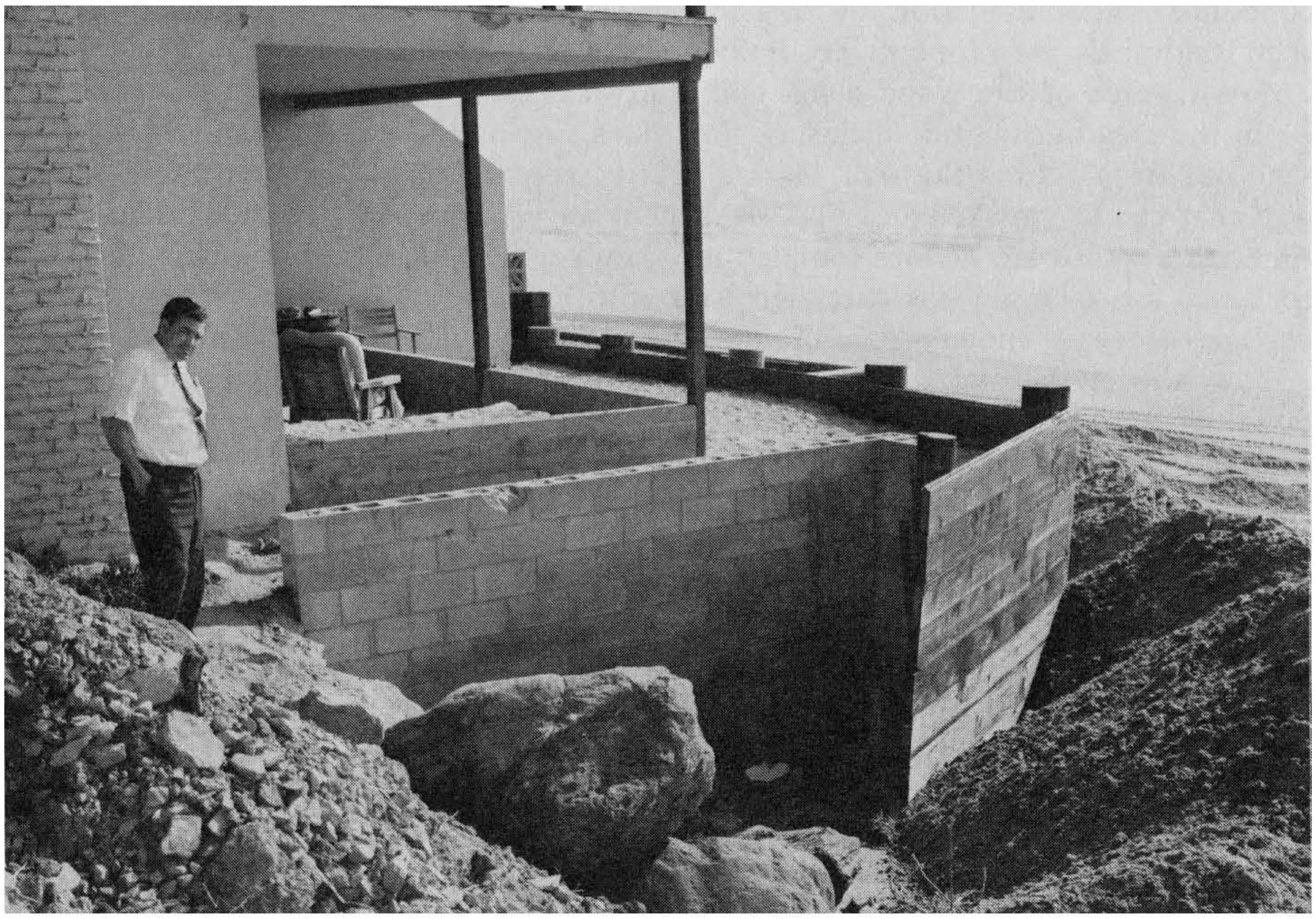


Figure 6-38 Robert W. Ross, supervising grading inspector for the County of Orange, CA, inspects a seawall extension constructed to minimize sand removal during high surf conditions. Photograph by C. Michael Scullin.

Figure 6-39 Excavation and grading for a beachfront condominium. A concrete seawall is to be constructed along the seaward side of the condominium in the approximate location shown. Photograph by and courtesy of Robert W. Ross.

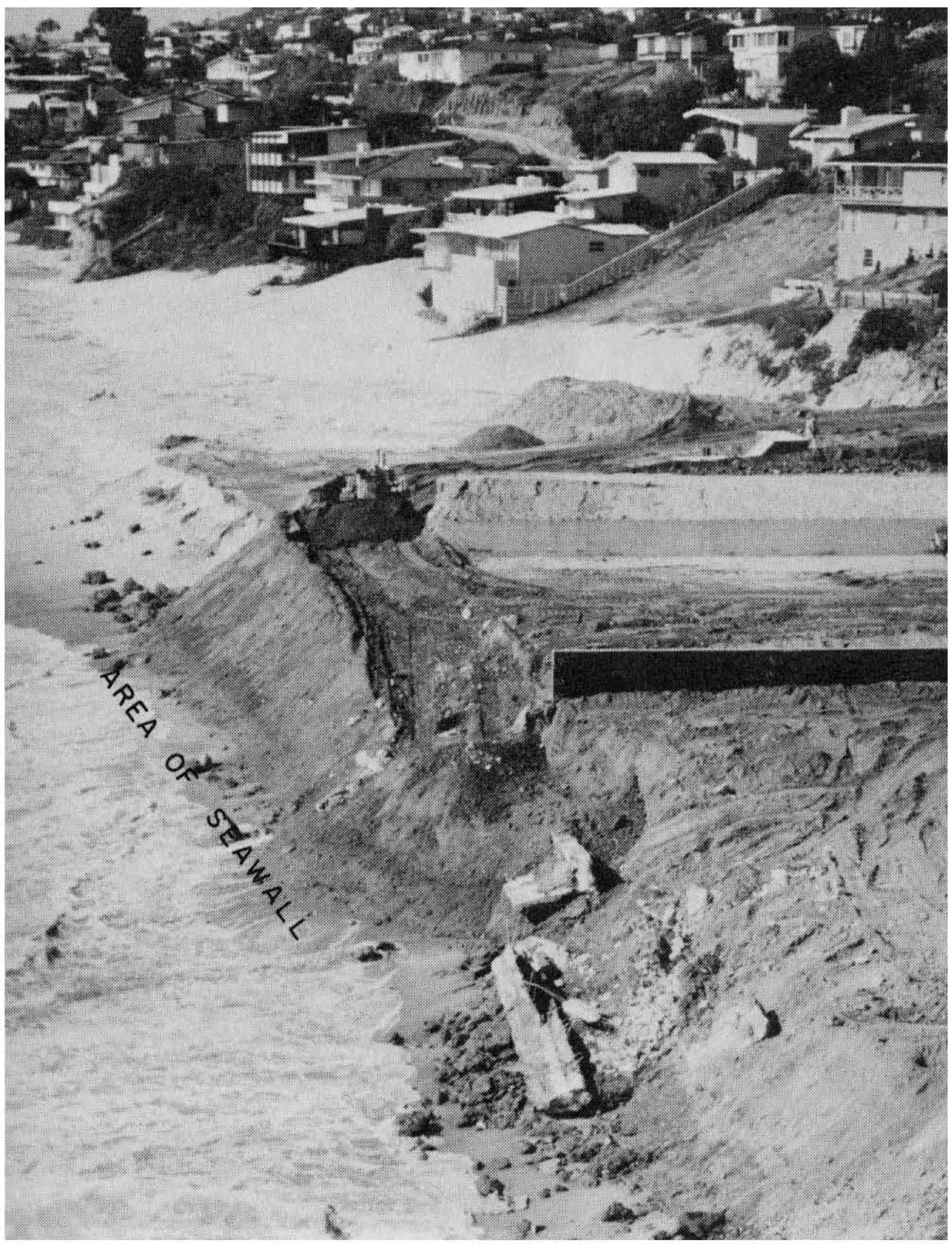
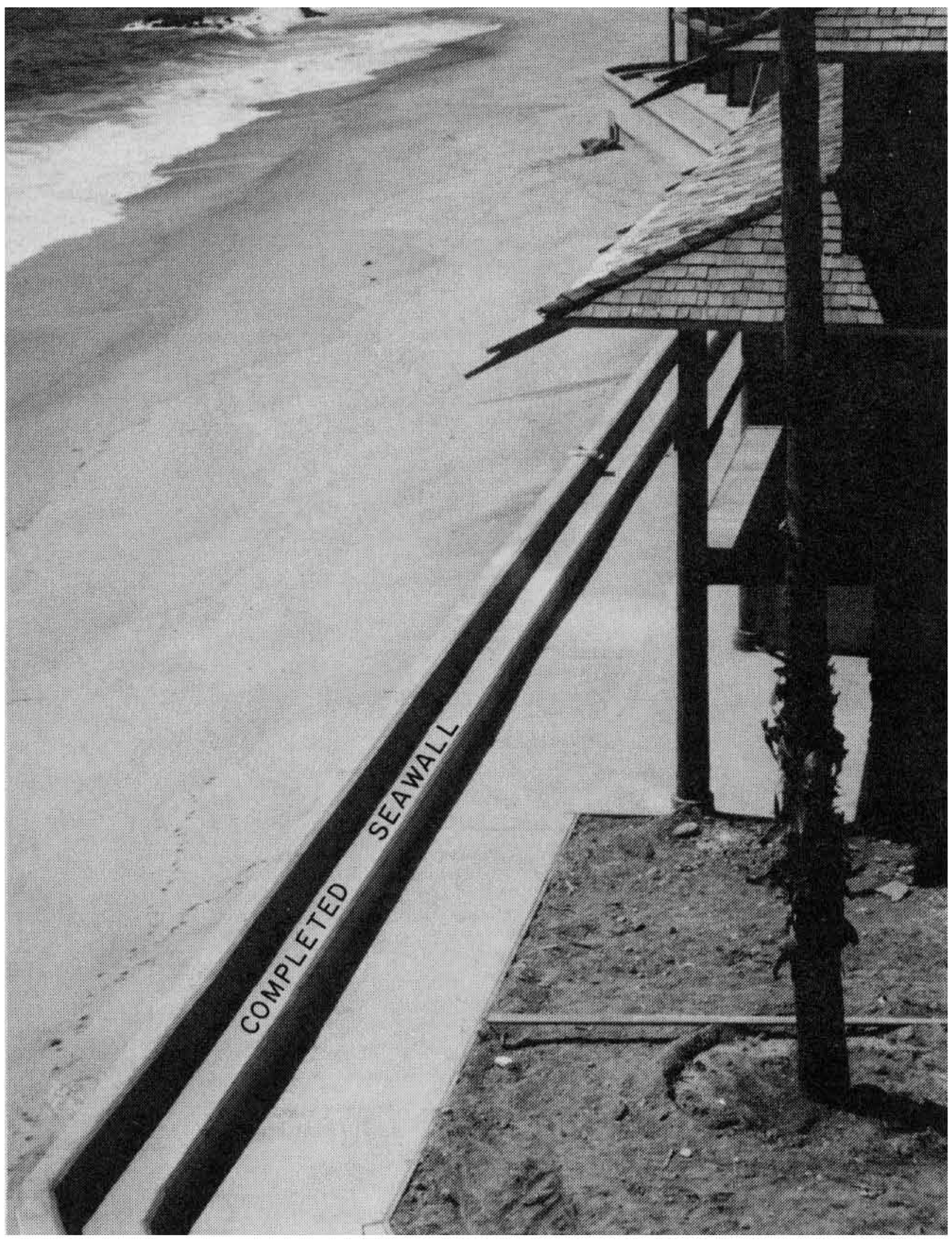


Figure 6-40 The seawall and condominium under construction in the preceding photo are shown here upon completion. Photograph by and courtesy of Robert W. Ross.



condominium construction on a much larger magnitude than is normally used for a single-family residence.

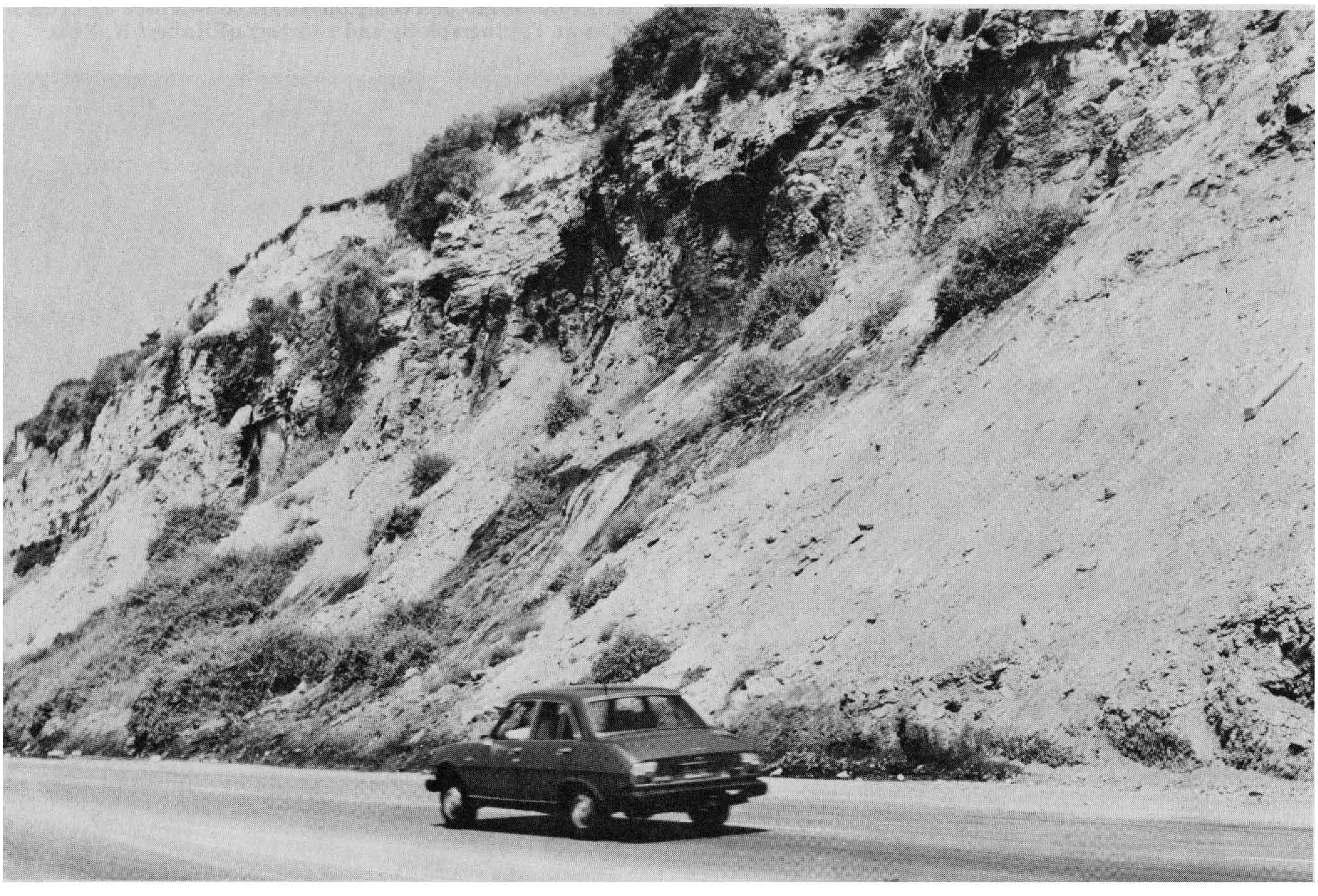
Most failures of the wood plank bulkhead walls seem to be in the area of high-tide/high-surf conditions surging the sand out from behind the wall, leaving it as a free-standing wall that can be knocked down by subsequent waves. Many times these walls are neither founded into competent bedrock nor are their returns extended back into the lot far enough or deeply enough to ensure that the ocean does not remove the lateral support of the walls. The grading or building inspector should make sure that these walls are designed to withstand the lateral force loads anticipated for that area of coastline, and that they are extended down into a competent bedrock with the lateral returns extended deep enough into the lot to provide safe protection for the wall, as well as for the residence. This condition also exists in some inland areas such as the Great Lakes where huge storms have caused extensive damage to beach-front residences. The beach-front cast-in-place foundations and sea walls illustrated in Figures 6-15 through 6-19 are examples of sound construction along the coastal beach areas that are prone to extensive erosion by the ocean.

6-9 COASTAL BLUFF AND RIVER BLUFF INSPECTIONS

Many miles of coastal and stream terrace bluffs in the United States are 25 to 100's of feet high. These bluffs are considered to be ideal view sites for expensive residential development. These cliffs vary significantly with regard to their retreat, depending upon the composition of their rock. The mass wasting or erosion of these slopes may be accelerated by the action of water from ocean or river acting on the base of the slope. Such action can cause landsliding or excessive rock fall.

When the grading inspector makes the pre-inspection of bluff site plans, he should require geotechnical investigations in these areas. Normally, the rate of erosion that takes place is known only by geologists and soil engineers who study that phenomena. Sometimes, however, local city or county agencies have informative data about this coastal or stream bluff erosion. When available, such data should be utilized in the pre-inspection and plan-check stages to assure the long-term safety of the proposed structures. See Figures 4-7 to 4-11 and 6-41 to 6-44.

Figure 6-41 Seepage along the coastal bluffs contributes to slope failures. Residential seepage pits located near the top of slopes contribute to water buildup. Photograph by C. Michael Scullin.



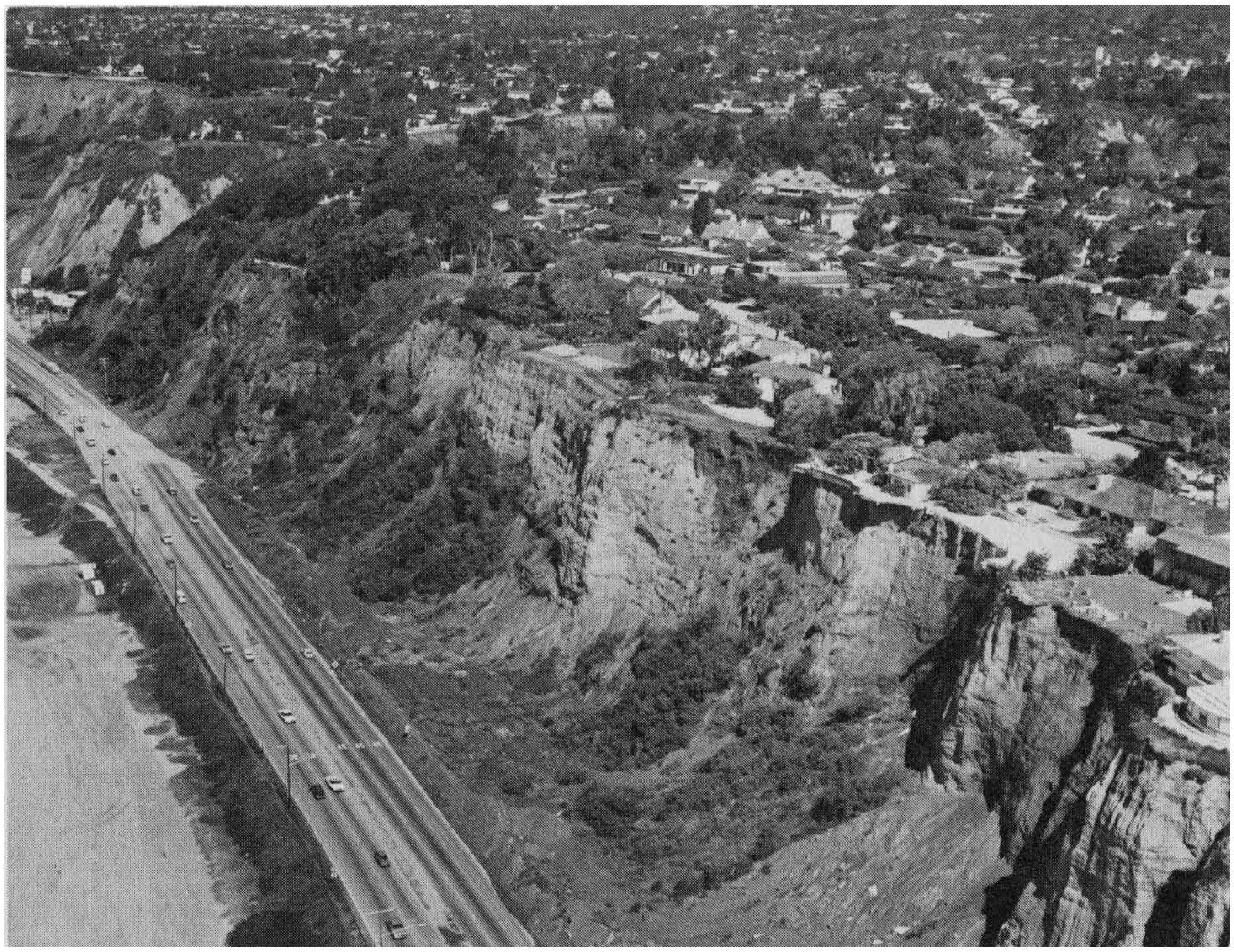


Figure 6-42 Coastal bluff erosion in progress in a well populated residential area. Along such bluffs highway maintenance and the repair of rear yard undermining are continuous, high-cost projects. Photograph by John Shadle, staff photographer, courtesy of the Dept. of Building & Safety, City of Los Angeles.

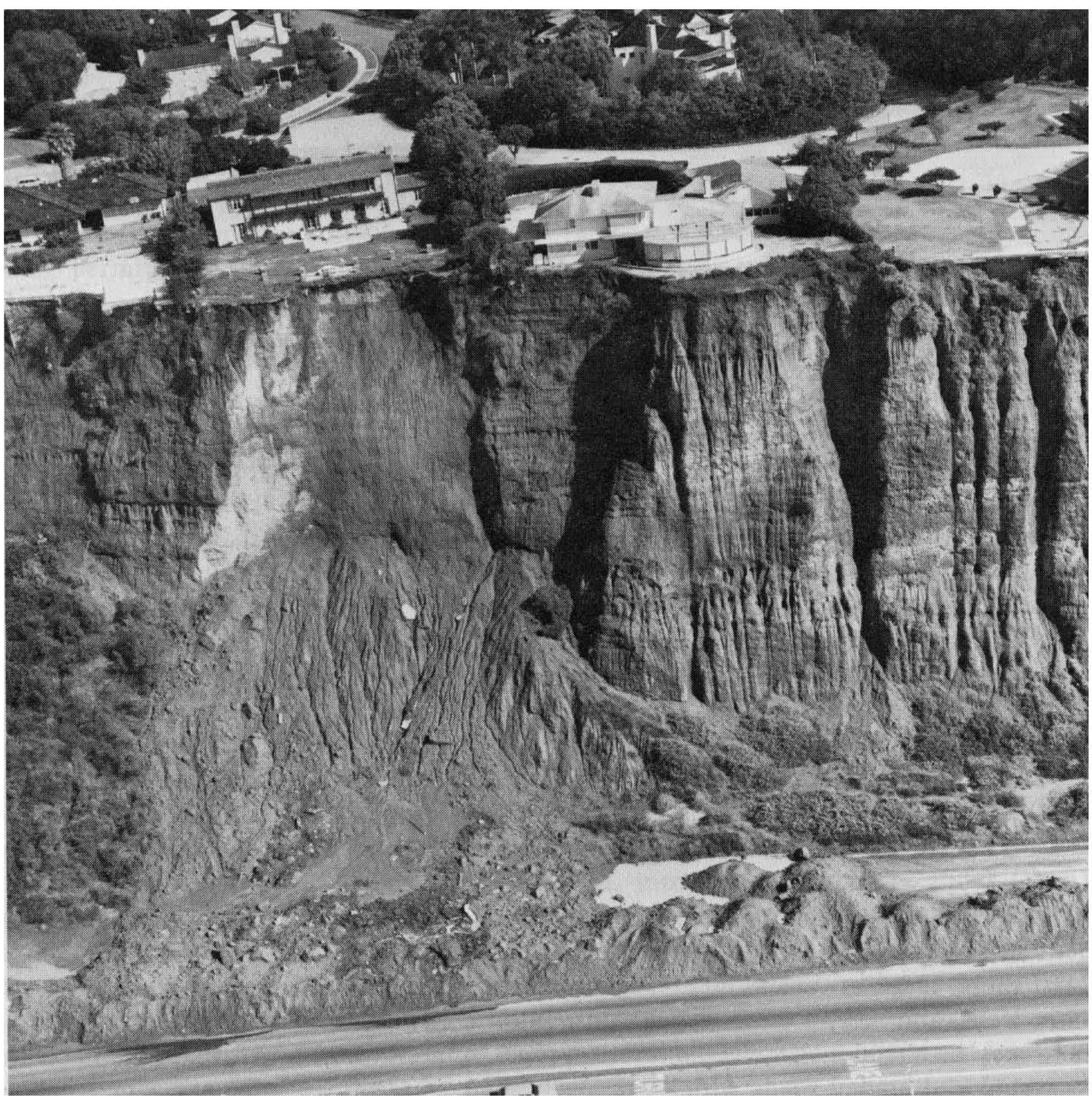


Figure 6-43 Coastal bluff rock fall and slide. Ploessel (1973:365) suggests that seacliff retreat in southern California may average less than 0.2 inches per year in volcanic rock, but as much as 1.5 feet per year in poorly consolidated Pleistocene terrace deposits. Photograph by John Shadle, staff photographer, and courtesy of the Dept. of Building & Safety, City of Los Angeles.

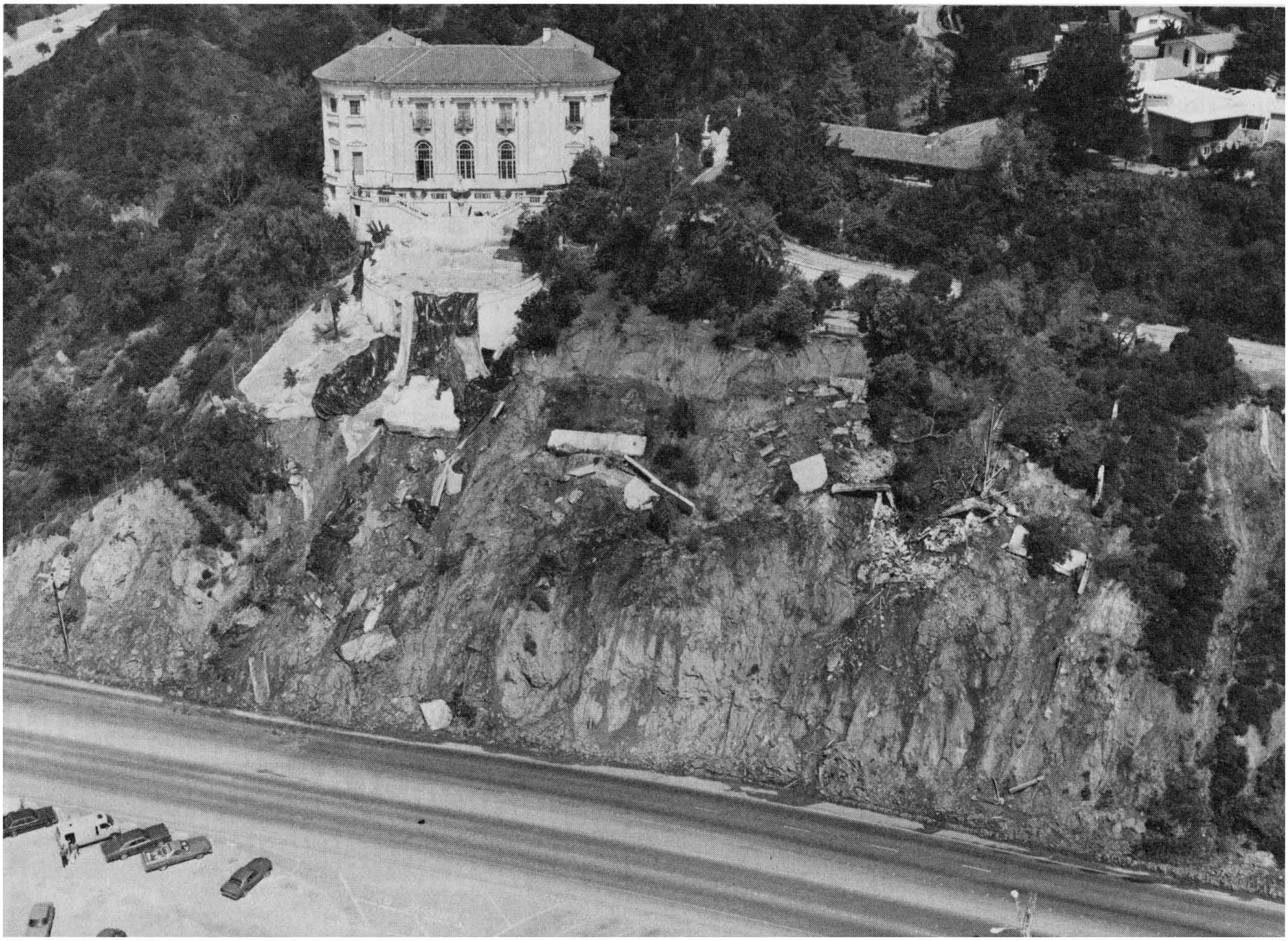


Figure 6-44 Here extensive erosion and sliding of coastal bluffs has undermined residential and rear yard structures. Photograph by John Shadle, staff photographer, and courtesy of the Dept. of Building & Safety, City of Los Angeles.

Once the rate of retreat of the bluffs is established, then the geotechnical recommendations relative to structural setbacks from the top of slope, or recommendations of toe of fill setbacks, or deep foundations or other forms of engineer-designed construction must be provided to assure a safe site. Recommendations may also include drainage control and possibly slope protection to reduce or minimize the bluff retreat.

6-10 ABANDONMENT OF SUBSURFACE STRUCTURES

Many areas, having had some form of cultural development in the past, come under urbanization. In agricultural areas there may be abandoned irrigation lines, cisterns, water wells, and cesspools or seepage pits. In oil field areas there may be abandoned wells, tank farms, pipes, numerous excavated and graded roads with loose fills pushed over the slopes, numerous graded pads with concrete slabs, and other structures that have been abandoned in the wake of urban development. In coal or strip mining areas there may be abandoned tunnels and subsurface cavities that are subject to eventual collapse. In the large limestone-karst terrain areas of the midwest and southeast United States, there are limestone sinks that cause cavities at the surface. Figure 6-45 illustrates a phenomenon where subsurface piping has been initiated, interestingly by gopher activity, which permitted infiltration of surface waters into the subsurface and caused extensive subsurface erosion, ultimately causing over-burden collapse resulting in a large cavity at the surface.

The abandonment and collapse of neglected subsurface structures cause surface settlement or collapse conditions that make new construction potentially unsafe. To prevent unsafe development, public records should be maintained and made available to appropriate personnel for necessary evaluation and geotechnical investigations of such condi-

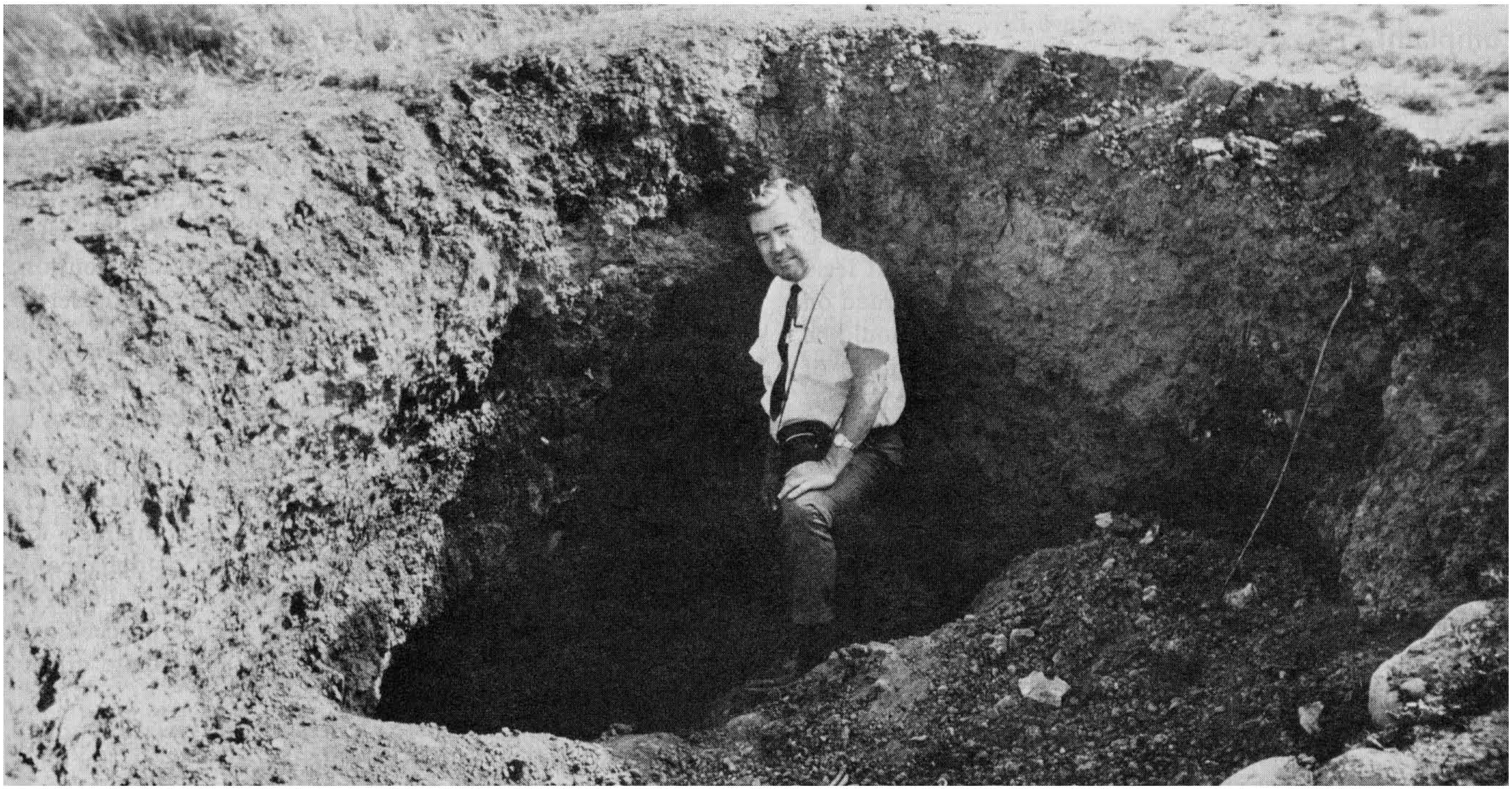


Figure 6-45 Robert W. Ross, supervising grading inspector, County of Orange, CA, stands in a collapsed piping tunnel. This type of collapse is caused by water flow into gopher holes that carried the water down into joints and fractures and pipe out at lower elevations. The subsequent collapse of the overburden leaves huge cavities and concentrates surface flow. Photograph by C. Michael Scullin.

tions. Resulting recommendations relative to the proper abandonment, and/or filling in or grouting of these conditions should be made a part of grading permits for site development. Both geotechnical and grading inspection should be a part of the stage approvals of development in these areas.

6-11 COMPLAINT INVESTIGATION AND REPORTING

Processing complaints is normally handled by grading section personnel at the public counter or on the telephone. Prompt, professional handling of complaints encourages good public relations through allowing members of the public to voice their concerns about construction. Often, citizens bring violations of the grading code to the attention of building officials who then can take corrective action.

As shown in Table 3-5, Chapter 3, the proportion of working time that grading inspectors spend handling complaints is relatively small. Nevertheless, they spend an average of three-quarters of an hour with each complaint. This time is usually considered to be part of their scheduled office time. However, separate timekeeping records could be maintained to keep track of such details if that information would be of value to management.

Complaint Processing

For efficiency, a complaint processing procedure should be established within the grading division. First, a complaint form or card should be developed, to be held in a complaint file, and ultimately in a grading file, should one result from the complaint. The complaint card should provide space for the following information: (1) name of city or county and the department of building and safety that has jurisdiction over the area complained about; (2) which branch office has jurisdiction, if there are branch offices; (3) site location complained about, identified by address, street map index page and number if available; (4) owner's name, address, and phone number, which may have to be obtained from zoning; (5) complainant's name, address, and phone number; (6) nature of the complaint (for example, that mud from rear slope came through the back wall of complainant's house, into the dining room and kitchen); (7) name and department of person who received the complaint; (8) whether complaint was received by phone, by letter, or in person; (9) note to whom the complaint was referred and to which district grading inspector it was forwarded for follow-up. The card should contain at least two lines for follow-up remarks.

Complaint Procedures

The procedure for processing complaints should be as uniform as is practical. Usually the procedure should include the following: (1) the person receiving the complaint should fill out the complaint form completely; (2) the receiver should forward the card to the land use division to verify the ownership of the property so the current legal owner's name, address, and phone number are recorded on the card; (3) the grading division or section files should be checked for past record of storm damage, violations, or complaints at the same location so that any existing records can be attached to the form; (4) all information should then be forwarded to the supervising or principal grading inspector. Any additional considerations or input by administration should be added to the form at that time so that the grading inspector will have all pertinent information available at the time he goes to the field to make the inspection.

Sometimes complaints are of an emergency nature, such as storm damage conditions, brush fire hazards, or earthquake damage. Such emergency conditions dictate notification of the inspectors to follow through immediately while they are in the field. The complaint form will be given to them upon their return to the office. It may be a disadvantage for the field inspector not to have all pertinent information at the time he is making his field inspection, but under emergency conditions it is better that his expertise is utilized immediately.

The normal complaint follow-up begins with site grading inspection, the report of which should include illustrations of the site condition by means of drawings or photographs, and notes of conversations with the complainants, owners, or participants regarding the site conditions.

At that time, the inspector must determine if a violation of the grading or building code exists, and, if so, whether a correction notice must be written. A notice to comply with the code should be written on the normal violation or correction notice form. If an unsafe condition or code violation is found, the owner of the property is given a reasonable time, normally 15 working days, to perform corrective action. If such a violation condition remains uncorrected after 15 working days, the violation and/or complaint file should be turned over to the investigative section of the building department for normal investigative follow-up. If the problem has been resolved through compliance with the code, the proper records should be filed for future reference. If the problem has not been resolved, and an existing grading permit was involved with the complaint (such as dust or erosion from the site, siltation of the site, or something involving the grading permit site), the grading inspector should follow through with regular grading permit enforcement to reach his objective of resolving the conditions. Available control methods include the withholding of building permits, rough-grade approval, or final approval and certificate of occupancy, in order to gain the necessary compliance with the correction notice.

6-12 VIOLATION INVESTIGATIONS AND REPORTING

There are several possible procedures for the processing of grading-code violations, the choice of which is dependent upon whether or not the work is still in progress, and whether or not an unsafe condition exists. An inspector investigates each complaint as it is brought to his attention, then determines what action should be taken in order to achieve compliance.

The Processing of Grading-Code Violations

If work is in progress and a stop-work notice has been given by the inspector, one of the following will occur: (1) corrective work and code compliance are completed immediately; (2) work stops, but there is no compliance or corrective work, in which case a hearing may be called with possible subsequent prosecution or injunctive proceedings; or (3) the work continues, resulting in immediate arrests and follow-up prosecutions.

When the grading inspector writes a code violation notice or stop-work order, he must specify the violations and code sections, describe the violation briefly and note the date and the time. He must specify what corrective action is required and give a reasonable time for the owner to comply. Fifteen days is standard, unless the violation requires immediate corrective action.

The inspector should give notice of violation to the property owner or his agent. If the owner is not available, a copy of the order should be mailed (certified, return receipt requested) to him after verifying property ownership with the land use division. A business card should be attached so the owner can contact the inspector upon receipt of the notice. Notes of these procedures should be included in the file.

The inspector should submit a copy of the violation notice, along with the sketches and/or photographs made at the site, to the supervising or principal grading inspector for review. If a senior grading inspector has been delegated the responsibility of violation follow-up, a copy of the information should be given to him. As soon as the supervising inspector receives the violation data, they should be forwarded to zoning personnel for verification of the ownership of the property and to obtain a legal description of the property.

All sketches, photographs, or illustrations of the conditions of the property should be detailed and accurate enough to give the supervisor a clear picture of the site conditions. If more detailed photographs than those taken by the field inspector are needed, the section supervisor should request that the department photographer take pictures, and the photographer should go into the field with the field inspector who should identify conditions to be depicted in the photographs. Such pictures should be identified by date, photographer, project or owner identification, address with a brief description of the location where the picture was taken, direction faced, time of day, and climatic conditions at the time the pictures were taken. Pictures should be kept in the violation file maintained by the grading secretary.

The field supervising inspector should review the violation information and take action as necessary. Normally he would notify the section or division supervisor of the details of the violation, and, if there exists any urgency or safety condition that must be corrected, the senior civil engineer or division engineer should also be advised of the details of the violation at that time. The grading secretary should set up a "tickler file" for keeping track of the dates of future department action. All files should be kept by the grading secretary, but it is the supervisor's responsibility to see that follow-up action is taken.

If no corrective action has been taken by the owner within the time specified on the violation notice, the supervising inspector should bring the violation to the attention of the grading supervisor or grading division supervisor who must review details of the violation, and, if necessary, re-inspect the site to determine whether or not any additional violations have occurred. The supervising inspector should personally make such a field investigation and be fully aware of all aspects of the violation for proper follow-up. The grading section or the division supervisor should then prepare a follow-up letter to the owner restating violations, specifying actions required by the owner and the time allowed for compliance. Ten days should be the standard at this stage. This information should be added to the tickler file, and a copy of the letter should be submitted through the division or senior civil engineer to the director of building and safety.

If Work Continues After Stop-Work Notice

If the violation notice ordered the work stopped, but the work continued, the grading inspector should immediately notify the field supervising inspector that the stop-work order is being violated and should immediately post a second stop-work order. The field supervisor should then contact the grading section division supervisor and the senior civil engineer with recommendations to be given to the director regarding action to be taken. Recommended action may be to obtain an injunction against further construction, to file criminal charges with the district attorney, and to ask the sheriff or the police to arrest the violators. The grading section personnel should immediately contact the police to initiate procedure for the arrest of all participants in the violation in progress, including all equipment operators. Such action effectively stops the work, and the operators are generally more than willing to tell the police who is paying them to do the illegal work. Warrants may be obtained for the arrest of the responsible property owner or agent.

Although the operators are normally released on their own recognizance since they usually were doing the work for a contractor or responsible agent, they should be booked along with everyone else so that they will consider the ramifications of such illegal actions in the future.

Once deemed necessary, police action should proceed immediately, without hesitation, and with rapid, efficient follow through. Successful prosecution of violations is contingent upon evidence gathered of the activities in progress in the field. If unsafe conditions exist, these must be made at least temporarily safe prior to stopping the project in its entirety. Although permanent safety correction may require much more time, temporary stabilization measures can be enacted while the equipment and operators are on the site.

Noncompliance or No Corrective Work

If a stop-work order or a violation notice has been given and the work stops, but there has been no compliance or corrective work in the time allowed, a violation follow-up letter should be sent by the grading supervisor to the owner or responsible agent of the property. This letter should be in the form of an enforcement hearing notice submitted through the senior civil engineer to the director of building and safety. This notice should establish a time, date, and place for a hearing at which the owner will be required to justify why he should not be put in jail at this time, or why the correction work has not been completed as required by code. The section supervisor or civil engineer should also notify the county council, district attorney, or city attorney, depending on whether or not injunction or criminal proceedings will be recommended at the hearing; he should then review all the details with the deputy attorney. The senior civil engineer, grading supervisor, and field supervising inspector must then review the facts and prepare a complete file for the enforcement hearing with recommendations to the director as to the course of action. These recommendations should be submitted to the director at least a week prior to the scheduled hearing. Copies of these recommendations should go to the responsible prosecutor.

An enforcement hearing is generally held in the office of the building director or in a hearing room. The director of building and safety should make the final determination concerning corrective action required of the owner. Both a verbal and a written summary of all required corrective action should be given so the owner knows exactly what he is supposed to do. The director should specify a time limit for compliance. The time should be sufficient to accomplish necessary work, allowing for lead time, preparing drawings, securing contractors, and the work itself. A copy of this notification should be placed in the violation file, one sent to central file, and one sent to the county council, district attorney, or city attorney's office. Another tickler file entry should be made for the enforcement hearing reports to indicate dates of future action to be taken by the department.

If the owner has neither acted nor received an extension of time from the director by the date set, the grading supervisor should prepare charges for legal action. The division engineer or senior civil engineer should submit charges and recommendations for legal action to the director for his approval. The grading supervisor and senior civil engineer should contact the legal division to review details of the case for possible criminal prosecution or injunctive proceedings.

Prompt action and attention to details is extremely important throughout this entire process. Care must be taken as follows:

1. Review by supervisory personnel must be prompt and complete.
2. A case file must be opened as soon as the violation is reported, and tickler file entries must be made to assure follow through.
3. Case records must be kept current and complete by the grading secretary to whom all data must be given.
4. Follow-up actions must be taken promptly as specified in notices.
5. All involved personnel should keep a *written* record of any conversations concerning the violation, including time, date, participants, and a brief summary of the discussion as well as any decisions made. Copies of these records should be given to the grading secretary for inclusion in the violation file.
6. It is extremely important that all records and notes be kept in chronological order.

In Chapter 5, Section 5-15, we discussed proper maintenance and closing out of the grading permit files. The attention to detail, and, in particular, the proper chronological order of documents, is essential in violation and complaint proceedings so that any subsequent court actions can make use of well-documented facts and data in an efficient manner. This reduces court time, which is appreciated by judges and juries, and saves taxpayers' money.

6-13 EXPERT WITNESS AND COURT TESTIMONY

Court and legal preparations must be accurate, detailed, responsible, and precise. All notes should be in order with all negative statements or personal opinions other than technical opinions eliminated. The file should include only the facts relative to the site conditions and the work, the violation notice, stop-work order, and the facts of the case. If the violation involves a grading permit or building permit, then all pertinent aspects of those permits should also be outlined and in order. All the photographs, illustrations, and notes of conversations and activities should be established in a chronological order, normally by date and time, and should be in a nearly tabular form, easily readable in court.

When requested or required to be an expert witness or provide court testimony, grading personnel should be properly dressed and have a clean, neat appearance. They should project confidence concerning the subject matter and should make the presentation in a manner that is clear, precise, and simple. Short, direct responses such as, "yes sir," "no sir," "yes ma'am," and "no ma'am," are preferable to answers that include personal opinions. Personal opinions are usually prejudiced, and attorneys will both ridicule and tear apart statements that are primarily based on a biased opinion.

Presentations should be concise reports presenting accurate, factual data in a manner that can be understood by both judges and juries. Verbosity, pomposity, and egotism are not well received by them, but opposing attorneys love it, because they can tear apart the egotistical bias of the testimony. The Court will have more respect for the witness who presents an air of humility.

As experts, grading personnel should be able to withstand normal questioning regarding their fields of service. Generally speaking, attorneys know very little about these fields, so the advantage is on the side of the witness as long as he sticks to the facts. When opinions are presented as testimony, the effectiveness of the witness will depend upon his knowledge and understanding of the topic, his appearance and manner, and his ability to be understandable and convincing. Simplicity, brevity, and accuracy are important keys to giving successful testimony.

6-14 PRIVATE ROAD GRADING

Private road grading is common in subdivisions or tracts where streets are to remain private, in planned community (PC) and planned development (PD) projects, and in lot splits. It is also common for fire roads in rural areas, for access roads to houses located on large acreage, for mines, and for sand and gravel pit sites. The most extensive road grading operations that affect single-family residential units are the mass grading of large developments graded as private property where the streets are offered for dedication for public domain, such as public highways, public streets, public ways, or public places that will be ultimately acquired by the city or county by purchase, dedication, or condemnation proceedings. Regulation of such construction, excavation, and fills within privately owned rights-of-way dedicated for public use has been greatly augmented by the grading division code enforcement inspection and the investigation, testing, analysis, inspection, and quality control of the developer's private geotechnical consultants.

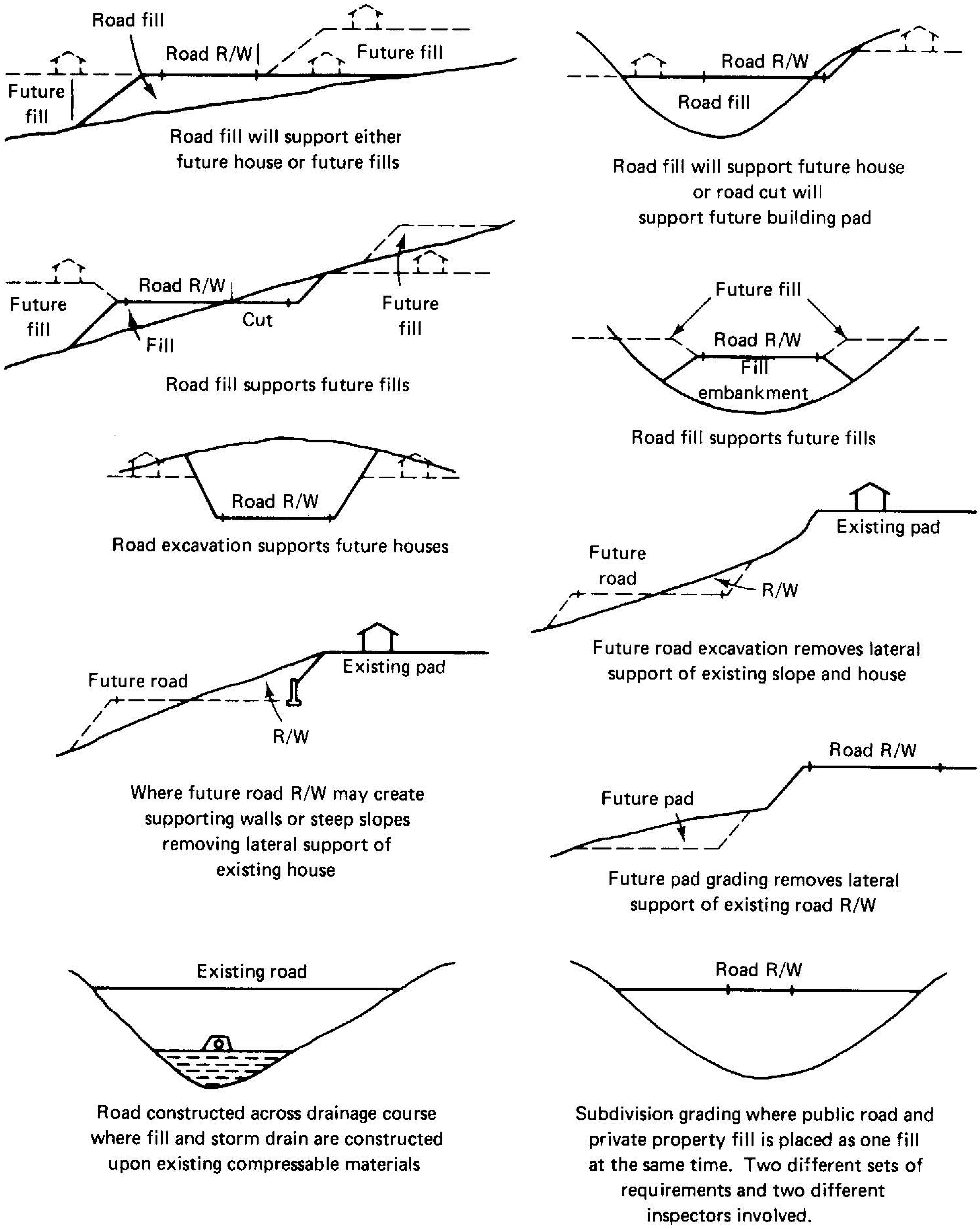
An example of an excellent regulatory program was an agreement between the County of Orange, California, County Road Department and County Department of Building and Safety, which resulted in Ordinance Number 1940 amending Sections 61.011 and 63.031 of the Codified Ordinances of the County of Orange, California. This instrument was approved by the full vote of the County Board of Supervisors on March 17, 1965. Though it unfortunately fell into disuse later, it was effective for several years and included regulation of many hundreds of miles of streets developed by private developers in the unincorporated territory of the County of Orange, California.

Under this agreement, regulatory control of mass grading up to rough grade by grading inspectors in the absence of improvement plan approval by the Road Department was a savings to the county because: fewer staff members were involved; there was less liability due to the supervision and certification of testing and compliance by the geotechnical consultants; and fewer problems arose because only one inspector with one set of requirements was needed on the site. It was no longer necessary to have multiple inspectors trying to enforce different sets of standards and specifications on the same grading project. This was clearly a savings to the developer and contractor in time and money.

The developer was required to provide the preliminary geotechnical investigations and analysis prior to grading approval. The geotechnical consultants were required by code to provide full-time soil-testing supervision and necessary geological mapping and inspection during grading. It was possible for fill placement to be made in the canyons uniformly for private property and for ultimate public road right-of-way, as the same fill mass was controlled by the private soil engineer. The private soil engineer also was required to certify to the stability of the subsoils beneath fills as well as the cut and fill slopes. All of these geotechnical approvals were provided to the Road Department prior to construction of the improvement sections. The Road Department inspectors then handled the sub-base and improvement section construction. The Road Department, which at that time did not have sufficient personnel to cover all the road grading jobs, was able to provide better service, and still obtain a liability-free graded site with less ultimate maintenance cost as well as control the improvement section construction.

The numerous site conditions where public road work encroaches onto private property, or where private property grading ultimately involves public roads, are illustrated in Figure 6-46. Both public and private construction must bear upon each other for stability and support. Figures 6-47 and 6-48 show the mass grading of tracts near the rough-grade stage when the street areas are ready for the sub-base

Figure 6-46 Public grading and private property grading often bear upon each other for stability and support. Some common types of field conditions that involved both purposes of construction are shown. Drawing by C. Michael Scullin.



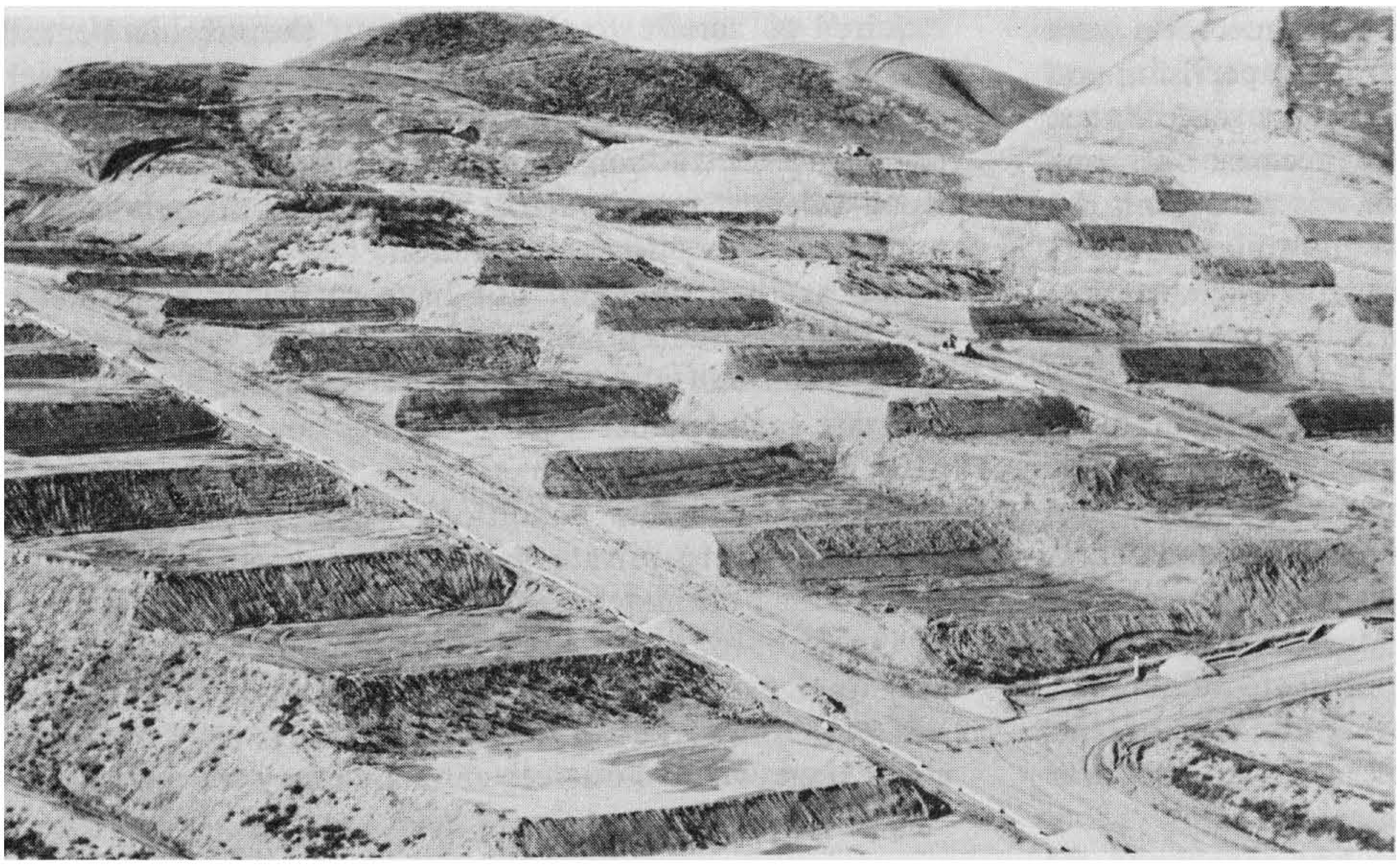


Figure 6-47 A hillside tract is shown here at rough grade prior to finishing the slopes, paving the slope drains, or providing drainage control from each building pad. Sewer line construction is about to commence. Photograph by and courtesy of Robert W. Ross.

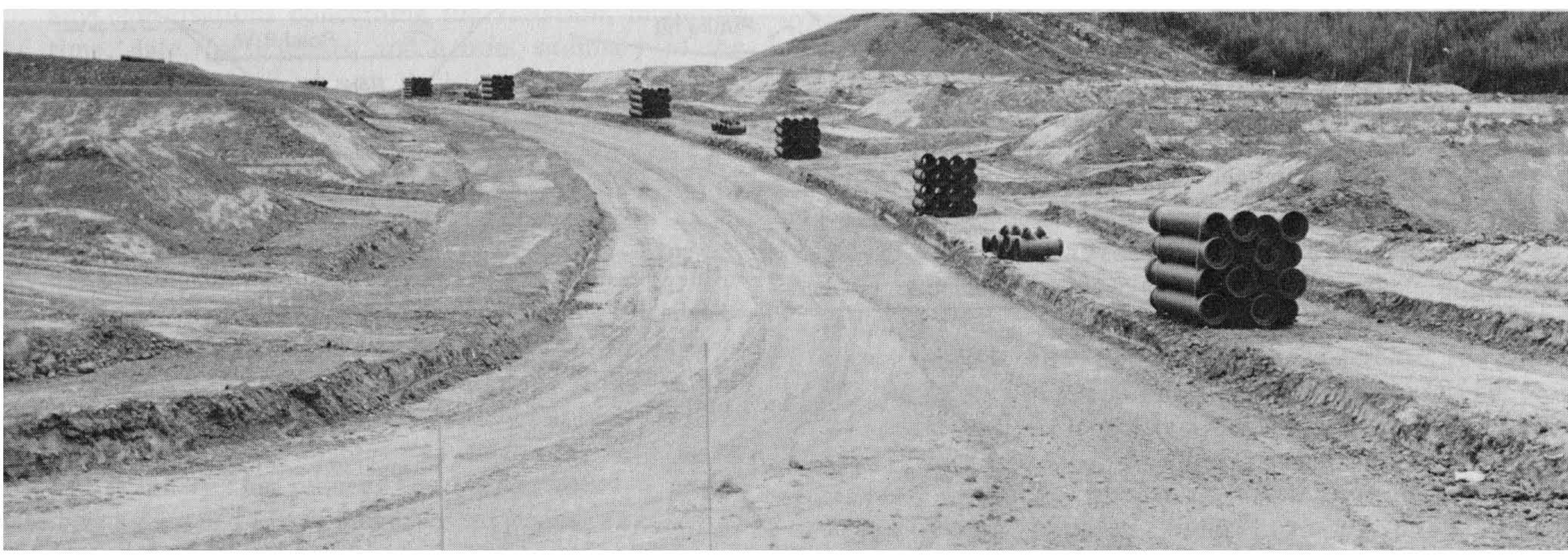


Figure 6-48 Tract slopes have been overfilled and cut back here, and the street, at rough grade, is ready to turn over to the Road Department for sub-base and improvement section inspection before sewer construction. Photograph by C. Michael Scullin.

Figure 6-49 This bicycle-skate walk adjacent to a public road has a paved drainage swale at left to protect the paved walkway from erosion. Photograph by C. Michael Scullin.

and improvement section construction. The sewer line and utility trench backfill compaction should be tested and approved by the site soil engineer prior to the improvement section.

The site grading requirements, specifications, and conditions of the permit are the same as described in Chapter 4, and the field quality control standards are the same as discussed in Chapter 5. The Road Department will have received a more thoroughly tested and controlled roadway prism than is normally the case and the geotechnical control of slopes and embankments is generally more complete when the work is controlled full-time by the private geotechnical consulting firms.

Streets that remain private, as in some lot splits, condominiums, and apartment tracts, should meet the minimum city or county standards for secondary streets. The main reason that developers build private streets is that private streets cost less than public roads. However, incorrectly built roads deteriorate rapidly. Minimum standards should be met for all such roads, as well as for parking lots, alleys, and access roads. In addition to these minimum standard requirements, the developer and the site geotechnical personnel should provide for the deputy plant inspection for the pavement and deputy inspection for storm drain, curb and gutter, and utility trench backfill compaction.

6-15 SUMMARY AND CONCLUSIONS

We have discussed and illustrated numerous grading-inspection field functions and methods other than those involving mass grading inspections. The relationship of such inspections to the earth sciences and geotechnical activity emphasizes the need for inspection by grading inspectors both to assure quality construction and to utilize grading inspectors effectively and efficiently. The effective utilization of grading inspectors' functions is a continuation of the review process methods of stage approvals and the continued checks and balances that improve the public safety and welfare through quality assurance inspection.

In addition to discussing special inspections and investigations, the processing of complaints and violations was discussed, along with suggestions regarding expert witness testimony. An effective method of mass grading inspection and control involving the ultimate public road right-of-way and ultimate private property development was discussed. It is an efficient method of grading control that provides reduced liability to the public agency and a cost savings to both the public and the developer.

In Chapter 7, we will discuss common types of storm damage and slope failure investigations and reporting. We will prescribe a format for surveillance and assessment of damage due to storms, fires, and earthquakes, and suggest a response model for grading division personnel.

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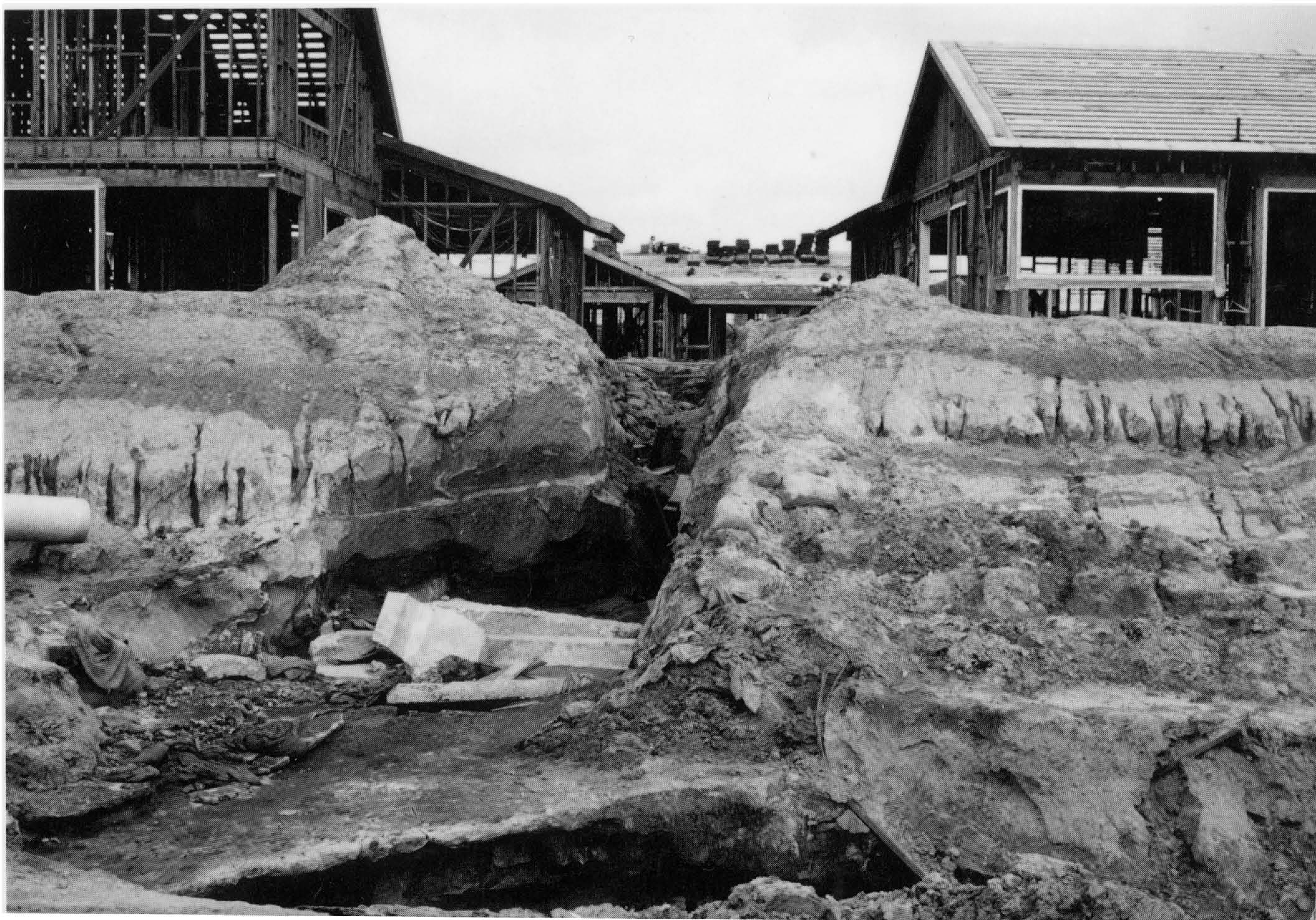

EXCAVATION AND GRADING CODE ADMINISTRATION, INSPECTION, AND ENFORCEMENT

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