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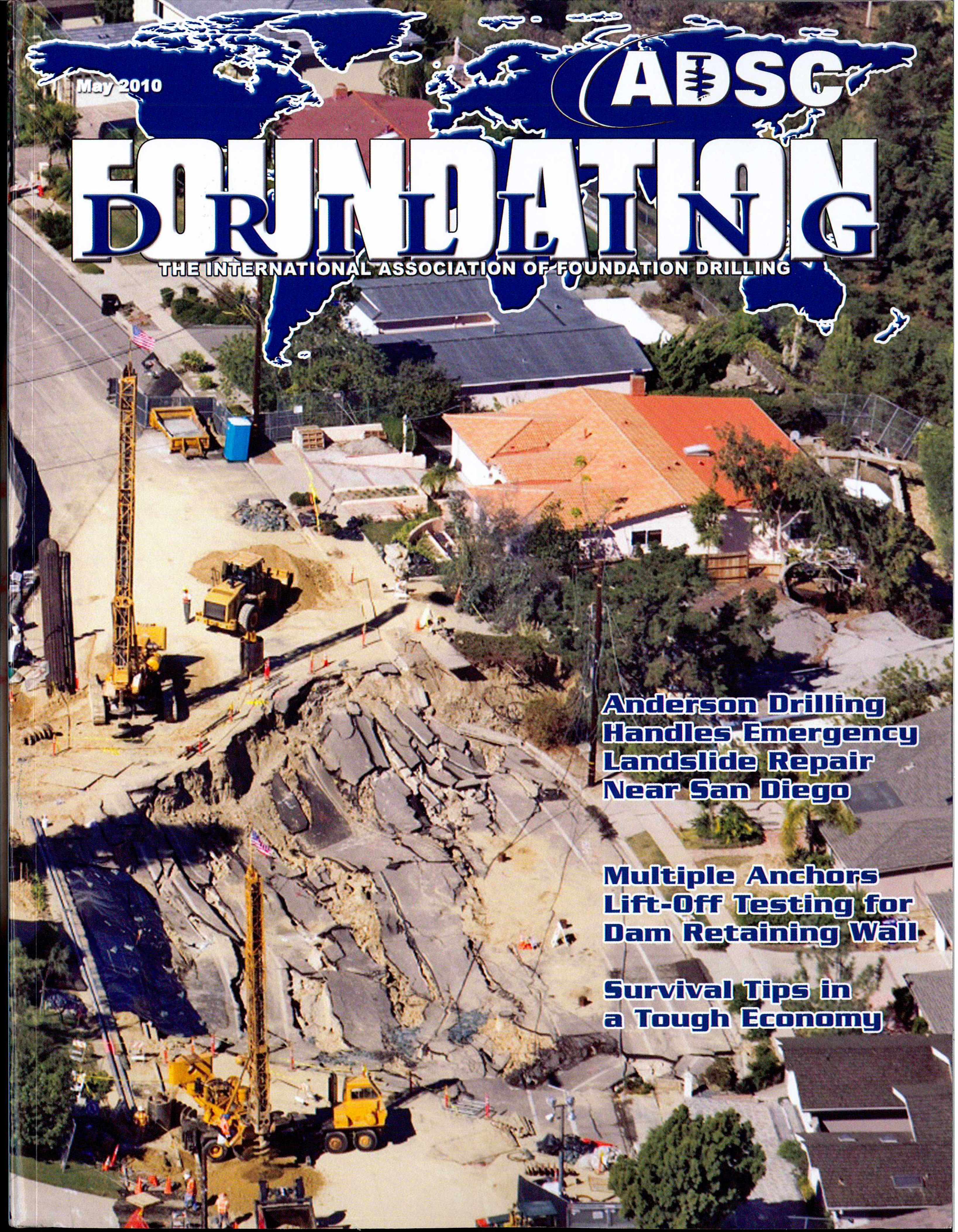

Anderson Drilling Handles Emergency Landslide Repair Near San Diego

Multiple Anchors Lift-Off Testing for Dam Retaining Wall

Survival Tips in a Tough Economy

Slip-Sliding-Away... Soledad Mountain Road Landslide Remediation

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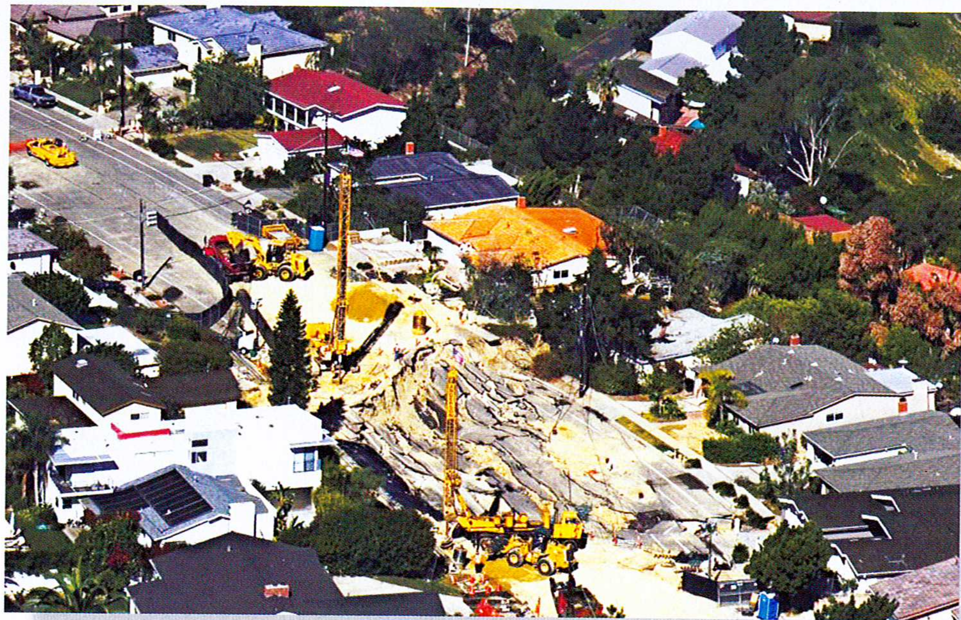

Anderson Drilling begins work on Phase 1 stabilization measures within 2-weeks of the catastrophic event.

Background

The morning of October 3, 2007, marked a tragic event in the lives of many residents along the 5700 block of Soledad Mountain Road. A catastrophic failure of the hillside occurred, destroying four homes, displacing approximately 200 feet of roadway, snapping overhead power lines and severing utility lines including gas, water, sewer, cable and telephone. The failure mass slid east covering upper Desert View Drive burying one home and isolating eight homes from roadway access. City emergency crews quickly arrived and evacuated dozens of homes surrounding the landslide through door to door searches and through public announcement from helicopter. California Governor, Arnold Schwarzenegger visited the site of the landslide and declared it a natural disaster which ultimately enabled State and Federal funding assistance for roadway repairs. Before the afternoon had arrived, nine homes were damaged and 'red-tagged', determined to be un-livable, no access permitted; eight others were 'yellow-tagged', designated unlivable with limited day-time access; and another forty-four homes were temporarily 'yellow-tagged' deemed un-livable due to all the broken utility lines that disrupted their services. The local electricity providers reported over 2,400 homes were without electricity as a result of the catastrophic event.

Aerial view of Phase 1 & 2 shear pin construction and slide debris remediation.

Soledad Mountain Road provides one of the major accesses to the community of La Jolla (The Jewel) within the City of San Diego. Real estate prices are some of the highest in San Diego County with many home values well above the $1,000,000 mark. Soledad Mountain Road serves over 10,000 vehicles per day.

The following article provides a

(Continued on page 23)

brief historic account of the October 2007 landslide and other related landslide events in the area, including a discussion of the landform and geologic setting that has contributed to the instability of Mount Soledad hillsides. ADSC Contractor member Anderson Drilling, Lakeside, California, provided services for the temporary stabilization efforts as well as the permanent repair measures in rebuilding the damaged portions of Soledad Mountain Road and Desert View Drive.

Located north of downtown, Mount Soledad is San Diego's most prominent land feature rising over 800 feet above sea level situated between Interstate 5 to the east and the Pacific Ocean to the west. The mountain top is highlighted by a 30-foot tall white cross which was erected in 1913 and now serves as the centerpiece of the Korean War Memorial. This vista point offers breath-taking 360 degree views of the Pacific Ocean and the southern California inland valleys and hillsides. Visibility on clear days can be well over 50 miles and include views of San Clemente and Catalina Islands to the west and the San Gabriel and San Bernardino Mountains to the north.

Landslide debris removal and shear pin key construction within the right-of-way.

The following article provides a brief historic account of the October 2007 landslide and other related landslide events in the area, including a discussion of the landform and geologic setting that has contributed to the instability of Mount Soledad hillsides.

Mount Soledad was formed as the result of faulting and displacement along the Rose Canyon fault zone. Ancient sediments of silts, sands and clays were initially flat lying similar to a layer cake. Tectonic forces in the Mount Soledad area have resulted in an uplifted block of these sedimentary layers. The fault activity that uplifted the Mount Soledad block also caused shearing along many of the weaker beds (clays and siltstones) and left them in a further weakened state. Where these beds were inclined on hillsides, ancient landslides developed. These ancient landslides were largely unrecognized as potential hazards during design and construction of residential subdivisions in the 1950s and 1960s in many areas of southern California. Consequently, numerous hillside developments rest over these ancient landslides which may re-activate years or decades after construction leaving a wake of destruction in their path.

The October 3, 2007 landslide was part of an ancient landslide which was not identified during residential construction in the late 1950's and early 1960's. A similar landslide immediately to the south occurred in December of 1961 resulting in destruction of seven homes under construction. (See Landslide Overlay figure which identifies the 1961 and 2007 occurrences). Additional sliding occurred on the 5600 block of Desert View Drive

Consequently, numerous hillside developments rest over these ancient landslides which may re-activate years or decades after construction leaving a wake of destruction in their path.

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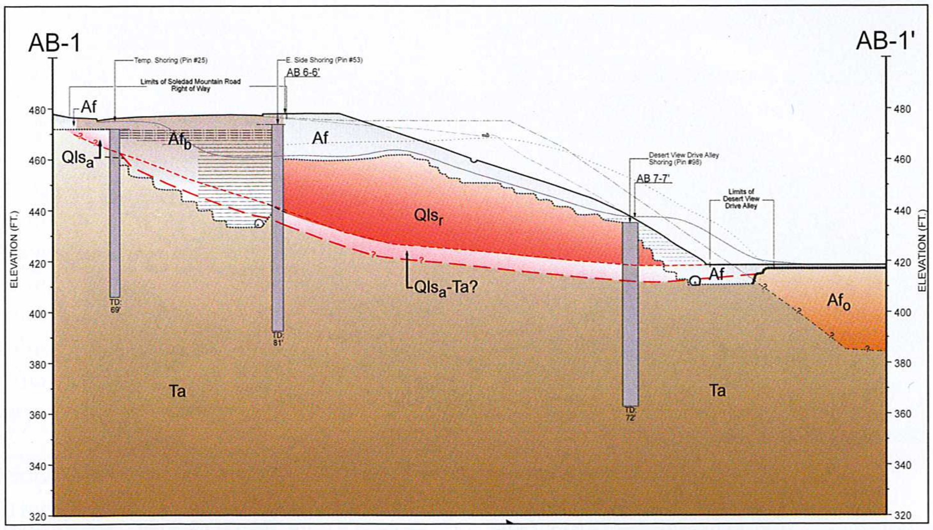
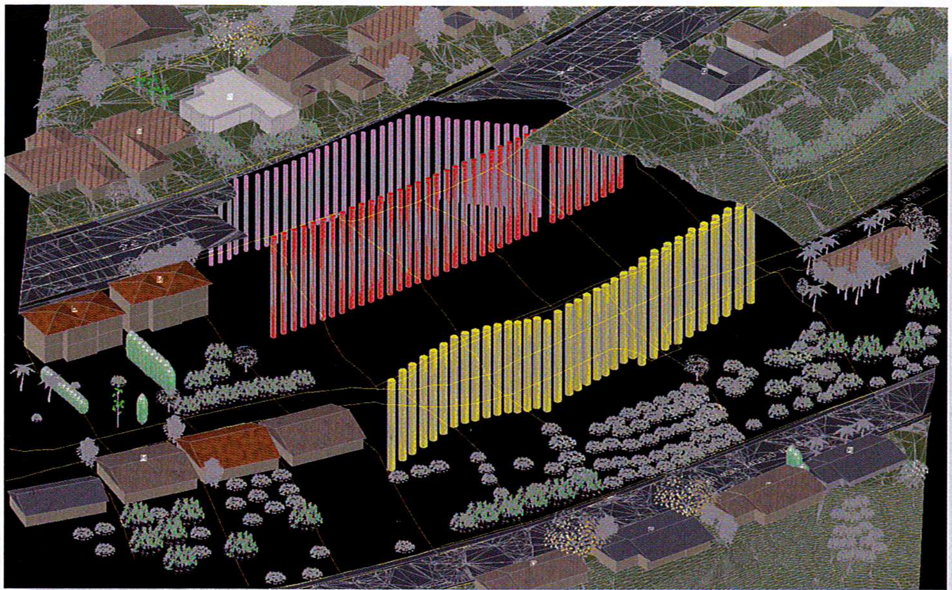


X-section of landslide repair scheme.



3D rendering of slide repair illustrating all three phases.

in 1989, and in 1994 a landslide affected the canyon below the 5800 block of Desert View Drive.

Landslide Occurs

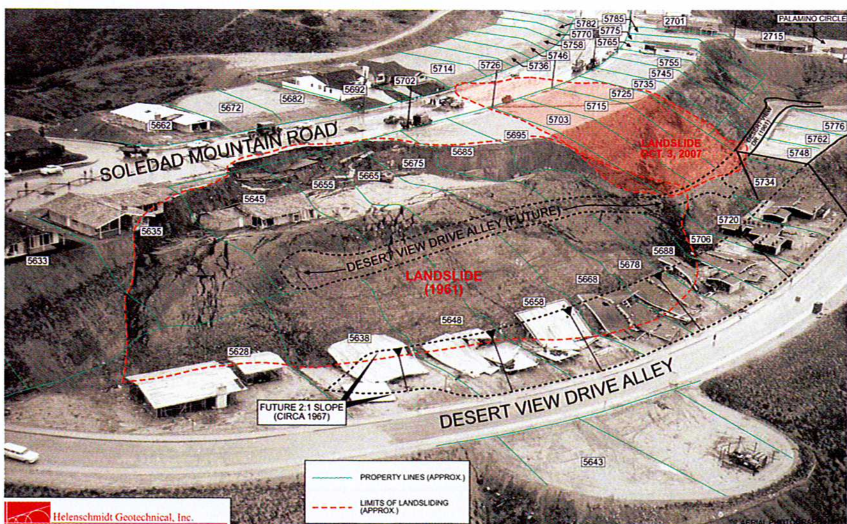
Distress in the form of asphalt street cracking, curb / sidewalk joint separations, water pipe utility breaks and distress to the home structures was increasing in the months, weeks and days before the massive failure. When it was recognized that the distress was likely due to landslide movement, the City of San Diego retained Helenschmidt Geotechnical, Inc. in early October 2007 to develop a mitigation design for the 5700 block of Soledad Mountain Road. It was recognized that stabilization would likely consist of a series of Cast-In-Drilled-Hole Piers (Shear Pins) in the Soledad Mountain right of way. Design of the repair would require characterization of the landslide through subsurface investigation. Prior to their authorization to proceed, Helenschmidt Geotechnical, Inc. had been to the site with City officials and had developed an investigation and design plan. The City had high-lined water services in the landslide area in order to prevent infiltration into the landslide due to potential water main rupture.

Upon authorization, Helenschmidt quickly mobilized and began installing a series of slope inclinometers in order to characterize the depth and rate of movement of the landslide. At this point in time, many of the distress features had become even more pronounced. Homeowners within the suspected landslide area were advised not to sleep in their homes the night before the catastrophic failure occurred.

On the morning of the mass failure, crews from Helenschmidt Geotechnical, Inc. were on site installing inclinometers and City representatives were inspecting residences when the asphalt street started to buckle and tear. Within moments it became apparent that catastrophic failure was taking place and on-site crews and City personnel worked to stop traffic and notify residents to evacuate the landslide area. As the roadway buckled and separated, the neighborhood could hear the sounds of the wood-framed homes snapping and cracking as they were sheared off their foundations and ripped apart. Trees and telephone poles snapped, power lines fell and the smell of natural gas filled the air. Thankfully, everyone managed to flee to safety.

> ***It was recognized that stabilization would likely consist of a series of Cast-In-Drilled-Hole Piers (Shear Pins) in the Soledad Mountain right of way. Design of the repair would require characterization of the landslide through subsurface investigation.***

The initial movement left an approximate 10-foot high vertical scarp that extended in arcuate north-south direction approximately 100 feet



Proximity of 1961 landslide occurrence to the 2007 event shown in red.

(Continued on page 27)

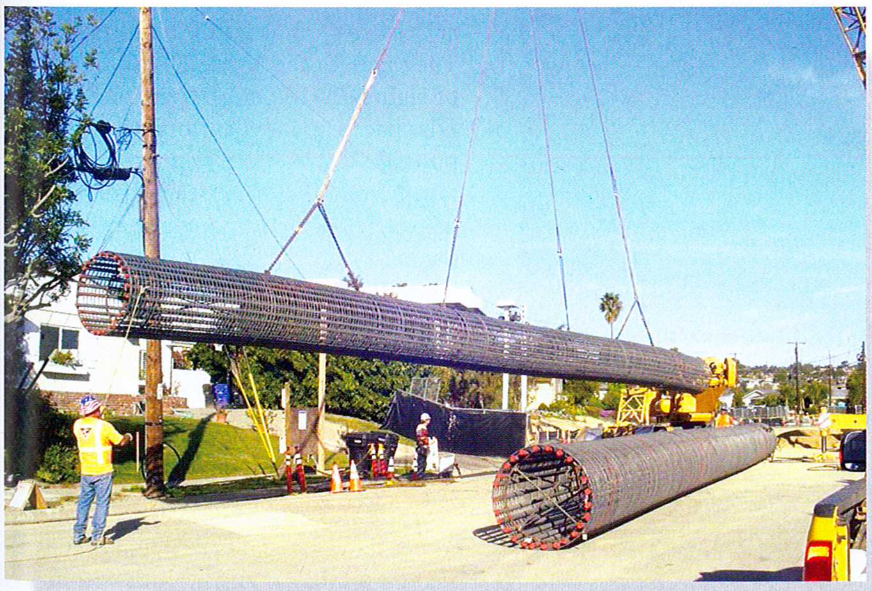
along the west edge of the street. Beyond this central 'back-scarp' area, the scarp extended and traversed diagonally across the street defining the northern and southern slide boundaries. The body of the landslide dropped 10 to 15 feet below the original street level.

The landslide movement soon subsided and the immediate safety concerns were addressed by City officials. City crews and San Diego Gas and Electric reacted quickly (e.g. shutting off water, capping ruptured gas lines, removing snapped overhead electrical wires) to reduce additional damage to both public and private properties. Within 48-hours Anderson Drilling was on-site drilling exploratory boreholes with a truck mounted Watson 3000* drill unit manufactured by ADSC Associate Member Watson, Inc. The 30-inch diameter boreholes were advanced to approximately 50 feet to 100 feet in depth. Properly equipped bucket auger drill rigs were then brought to the site to enable Certified Engineering Geologists from Helenschmidt Geotechnical, Inc. to perform "down-hole logging" of the subsurface conditions and identify the existing slide surface(s) and other potential adverse conditions that could factor in remedial design measures.

Installation of 54" diameter x 80 ft deep shear pins for Phase 2.

The City of San Diego faced several immediate challenges including preventing expansion of the landslide, rerouting traffic, providing access to residences cut off by the landslide and protecting homes in the path of landslide debris if rains were to initiate debris flows. Rapid assessment of potential hazards was performed and a map was developed identifying areas of potential impact. Weatherproofing of the slope was performed to reduce rainfall infiltration. Subsurface investigation continued late into the nights to acquire critical subsurface data to allow short-term stabilization measures to be developed. Within weeks, plans for the stabilization of the head-scarp region were prepared. The first phase of construction included a row of 37 shear pins positioned behind and along the head-scarp. The purpose of the pins at this location was two-fold; to mitigate potential head-scarp retreat and to provide an earth retention system to allow for the anticipated 30-foot deep removal and replacement of the landslide debris necessary for roadway reconstruction. The second phase included constructing a row of 38 shear pins, along the Soledad Mountain Road easterly right-of-way. These pins were designed to provide support for roadway and utility reconstruction. The third and final phase involved the installation of 44 shear pins at the base of the slide along the westerly edge of upper Desert View Drive followed by slope reconstruction. This final row of shear pins provided stability to Desert View Drive and allowed restoration of access to residents at the south end of Desert View Drive.

Within 48-hours Anderson Drilling was on-site drilling exploratory boreholes with a truck mounted Watson 3000* drill unit manufactured by ADSC Associate Member Watson, Inc.



Phase 1 & 2 cages weighed up to 36,000 pounds.

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Installation of Phase 3 cages weighing upwards of 42,000 pounds.

Construction Phases

Construction of Phase 1 began on October 30, 2007. Anderson installed 23 shear pins (42-inch diameter x 60 feet deep) using a truck-mounted Watson 3000 along the northerly side of the scarp and 16 shear pins (48-inch diameter. x 66 feet deep) using a Watson 3000 crawler along the head-scarp portion of the slide. Pins in this phase were spaced at seven to eight feet on center. A sequenced pattern of drilling every third shaft was required to avoid disruption of fresh concrete curing in adjacent boreholes. Equipment was also mobilized to enable geologists from Helenschmidt Geotechnical, Inc. to downhole log selected boreholes and confirm the subsurface geologic structure. A total of nine shafts were downhole logged in this phase. Upon completion of the shaft excavations and approval process, robust Grade 60 steel reinforcing cages were installed using a 240-ton hydraulic crane. The truck crane was preferred over a crawler due to its ease of mobility around residential streets and the slide mass. The reinforcing cages for the 42-inch shafts were assembled with fourteen #18 vertical bars (2¼ -inch diameter) and #4 spiral (½ –inch diameter) spaced at 3 inches, total wt of 10,400 pounds. The cages for the 48-inch shafts consisted of eighteen #18 vertical bars and #4 spirals spaced at 3 inches, total wt of 20,760 pounds. Crews were kept at a safe distance from the slide scarp using a 52-meter concrete pump to deliver the 5,000 psi hard-rock concrete mix to each shaft location. Two inclinometers were installed in these perimeter pins to verify their performance during and after the phased construction.

The City of San Diego faced several immediate challenges including preventing expansion of the landslide, rerouting traffic, providing access to residences cut off by the landslide and protecting homes in the path of landslide debris if rains were to initiate debris flows.

Phase 1 & 2 shear pin walls complete remedial slope grading and preparation for Phase 3.

Phase 2 construction began March 3, 2008 and involved work across the upper portion (graben area) of the slide mass. The geotechnical engineer excercised caution to permit only small sized equipment in limited numbers during work within the upper slide mass. Minor grading to provide

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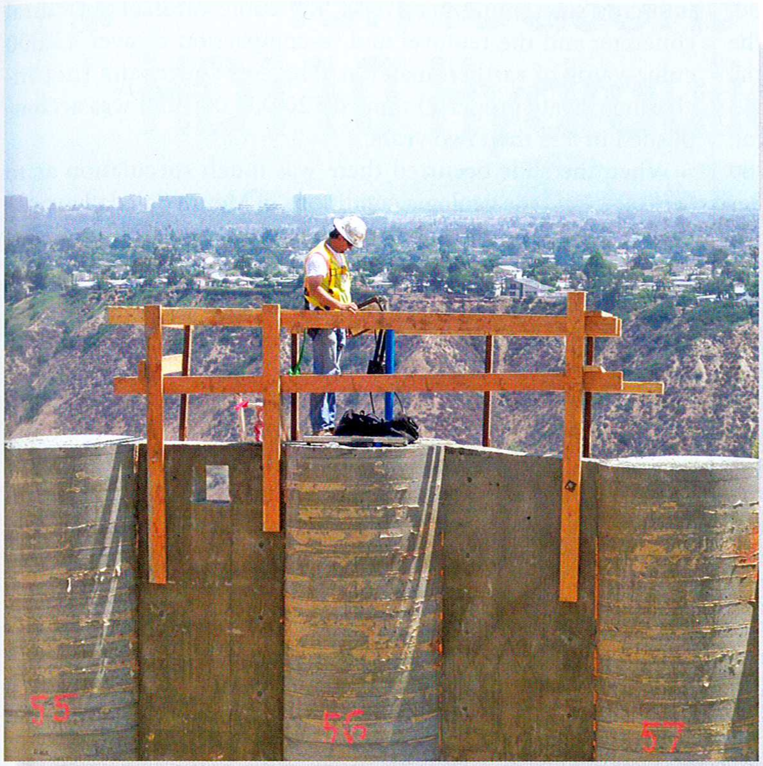

Monitoring pin deflection on Phase 2.

for equipment ingress and egress for our Watson 3000 crawler rig was performed with bobcat- type equipment. A total of 38 (54-inch diameter x 81 feet deep) pins spaced at 8.5 feet on center were excavated in a similar sequenced operation described in Phase 1 to control excavation exposure and permit subsurface logging. Reinforcing cages consisting of twenty six #18 bars and #4 spiral at 3-inches on center and weighing up to 36,000 pounds, were designed and fabricated to provide shaft rigidity. A 300-ton hydraulic crane was used to place these steel cages. With a maximum reach requirement of nearly 100 feet, we situated the crane on the south side of Soledad Mountain Road just behind the slide back-scarp and supported it with concrete filled drilled shafts beneath the rear outriggers. The upper 10 to 12 feet of the shear pins were formed above the working ground surface within the graben debris. A 6,000 psi concrete mix was placed in each drilled shaft. Once the shear pin installation was complete a 12–inch thick structural “lagging panel wall” was constructed between each exposed portion of pin allowing for engineered fill to be supported during the roadway reconstruction phase. Completion of the Phase 2 shear pins, removal and replacement of landslide debris within the Soledad Mountain Road right-of-way allowed restoration of Soledad Mountain Road for traffic during installation of the Phase 3 shear pins at the lower portion of the landslide. On October 17th, 2008, one year after the landslide failure, Soledad Mountain Road reopened. The concrete panel walls and Phase 2 shear pins formed a retaining wall that provided support for the roadway while the remaining work was accomplished.

> ***Construction of Phase 1 began on October 30, 2007. Anderson installed 23 shear pins (42-inch diameter x 60 feet deep) using a truck-mounted Watson 3000 along the northerly side of the scarp and 16 shear pins (48-inch diameter x 66 feet deep) using a Watson 3000 crawler along the head-scarp portion of the slide. Pins in this phase were spaced at seven to eight feet on center.***

> ***Once the shear pin installation was complete a 12–inch thick structural “lagging panel wall” was constructed between each exposed portion of pin allowing for engineered fill to be supported during the roadway reconstruction phase.***

(Continued on page 32)

Phase 2 shear pin panel wall.

Installation of the Phase 3 pins began November 10, 2008. The purpose of this work was to stabilize the hillside along the west side of upper Desert View Drive. Securing the base of the slide area was a critical step to allow for public safety when travelling on upper Desert View Drive. Helenschmidt Geotechnical, Inc. accomplished this by designing 44 (72-inch diameter x 80 feet deep) shear pins along the slide toe. This construction effort presented unique challenges due to the limited access to the site and tight space constraints at the work area. The street, more like an upscale alleyway, measuring approximately 20 feet in width, is bound by million dollar homes on the east side and an ascending slope with million dollar homes on the west side. This limited ingress and egress, as well as the size of our support equipment including: service trucks, loader, concrete trucks, concrete pump, crane and drill rig, made for a challenging working environment. The slide debris at the toe could not be removed until after the hillside was stabilized. A road was gingerly graded on top of the slide debris to provide access for our SoilMec SR60* drill unit, manufactured by ADSC Associate Member SoilMec S.p.A. The limited work space prohibited us from building the cages on-site or even having them delivered in close proximity to the shaft. The solution was to lift them from a delivery truck parked down below the work area on lower Desert View Drive. This solution stretched our reach requirements, up to 130 feet, and drove the crane size up. We determined that in order to hoist cages, weighing upwards of 42,000# from that lower street location, we could use a 300-ton hydraulic crane for the majority of the work but a 500–ton hydraulic crane would be necessary for some critical picks. A work pad engineered with a 9-foot thick geogrid reinforced earth mat was constructed in adjoining yard space between two of the damaged homes to support the cranes. Concrete was delivered to the shafts via a 52-meter concrete pump which was positioned as needed above the work area at along the now repaired (but not quite completed) Soledad Mountain Road. As with the other phases of installation, geologists preformed down-hole logging to document subsurface conditions.

On October 17th, 2008, one year after the landslide failure, Soledad Mountain Road re-opened.

Conclusion

In conclusion, a total of 119 shear pins were installed to stabilize and re-construct the slide damaged area. Shear pin construction included the installation of more than 3,655,000 pounds of reinforcing steel, pumping over 6,500 cubic yards of structural concrete, and the removal and re-compaction of over 43,000 cubic yards of earthen material. The cost for repairs (not including private property) topped $20,000,000 and was accomplished in less than two years.

When the slide occurred there was much speculation as to the cause(s). The geologic conditions of Mount Soledad expose the area to hillside instability. Prior to the catastrophic event, there were several signs of distress to both public and private property suggesting mass movement. The plaintiffs in the inevitable lawsuit against the City of San Diego believed that a water main break near the head of the slide initiated the movement. Defendants in the lawsuit countered that the block of earth that failed was a remnant of an ancient landslide that did not fail but was left in place during the repairs to the 1961 slide episode. They contended that the slide caused the water main break along with the rest of the distress. A recent judge's ruling in favor of the defendant's point of view cited the inherent geologic instability of the area contributed to and controlled this unfortunate event. The fact that all of the 119 shear pin boreholes were dry may have affected the decision.

**Indicates ADSC members.*

Project Team

Foundation Drilling Contractor:	Anderson Drilling Jim Forcier, Project Manager Josh White, Senior Project Manager Charlee Bixby, General Superintendent Paul David, Eric Deen and Paul Lesmeister, Superintendents
Geotechnical Engineer:	Helenschmidt Geotechnical, Inc. Stan Helenschmidt, Principal Geotechnical Engineer Brian Olson, Project Engineering Geologist Rupert Adams, Project Geologist Mike Hart, Consulting Geologist
Outside Services:	Marco Crane Company Merli Concrete Pumping Vulcan Concrete American Rigging White Cap Suppliers