

March/April 2003

# FOUNDATION Drilling

**Anderson Drilling Tackles  
Drilled Shafts for  
Denver, Colorado's T-REX**

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# A Good Monster Project Through Downtown Denver

By S. Scot Litke

The \$1.6 billion Transportation Expansion Project (T-REX) is being billed as the largest Design Build transportation corridor project ever built in the United States. So says U.S. FHWA Administrator, Mary Peters. It certainly is as far as the Rocky Mountain State of

Colorado is concerned. T-REX is a community supported project led by the combined efforts of the Colorado Department of Transportation (CDOT) and Regional Transporta-

tion District (RTD), and U.S. Department of Transportation, along with numerous counties, cities, and juris-

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*T-REX, I-25 Improvement cuts north-south right through Denver.*



*The bottlenecks to be alleviated by widening the roadway. Note drilled shaft soldier wall under construction.*

dictions. According to the T-REX authorities, "T-REX is the next step in the evolution from an aging, outdated transportation system to a modern integrated network of highway and light rail options." As such it is the first time that CDOT and the RTD ever teamed-up on a project. In fact, this is the first co-owned transportation project in the U.S. This 17 miles of highway through the heart of downtown Denver carries more vehicles than any other corridor in the state. For example, the I-25/I-225

*(continued on page 3)*

**Produced and Directed by Anderson Drilling** *The making of a drilled soldier pile wall, step by step.*



*The rig and the soil*



*Keeping the tool at maximum efficiency*



*Denver area practice of "mudding the hole"*

interchange is currently rated the 14th most congested interchange in the U.S. The project consists of constructing new light rail transit and making highway improvements. Thirteen bridges will be replaced. Eight interchanges will be reconstructed. In all 61 bridges will be built. All of this is very good news for ADSC Contractor Anderson Drilling, Denver, Colorado. The regional subsidiary of San Diego-based Anderson is on line to install over 7,000 drilled shafts for the project's soldier pile retaining walls, as well as several hundred-drilled shaft foundations for the crossover bridges.

The work began in the fall of 2001 with a completion date of fall 2006. The project is more than a widening of the road. While extra lanes of traffic will be added to relieve congestion and make way for expected growth, improvements in ramp access and egress, expanded shoulders, and drainage upgrades are important project components. Flooding on interstate I-25 has been a long-time problem. A chronically flooded storm sewer system in the south Denver stretch of the road will be replaced. As it happened during the time I was on the site preparing this article, a freak September rainstorm hit, of all places, the corridor itself. The roadway was flooded with

over 4 feet of mud, silt, and water. TV crews and the print media were quickly on the scene whose reportage only served to confirm the need to improve the drainage system that has plagued the highway system in south Denver. The mud was clearly an after-product of the construc-

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tion itself as the roadway lengthening has resulted in soil and rock stockpiles along the corridor. This, however, was not the cause, but rather a result of the problem.

Before we launch into the design and construction aspect of the project, it is interesting to note the extent to which the ownership partners, along with the D/B team led by Kiewit (the major JV partner), went to prepare the community for this

mega-project. It was certain that the undertaking was going to lead to significant dislocation and major inconvenience for the traveling public in general, and most directly, the residents and business operators located immediately adjacent to the construction corridor. A high-powered public relations advance team of Kiewit and the Southeast Corridor Constructors representatives led by Karen Morales for the JV partners, and Tim Nelson for SECC, went to work early-on with town meetings, supportive and positive media coverage, and door-to-door consultations. There is even a daily update of what is scheduled and what is to be expected on a special real-time, T-REX website. The "outreach planning" began in the summer of 2000. The owner's publicized goal is to minimize inconvenience to the traveling and resident public. To this end the project was telescoped down to five, from the original seven-year completion projection. It should be pointed out that Denver does not have any other thoroughfares that can handle the daily north-south traffic flow. The I-25 corridor dissects the city's heavily used entertainment and recreation sector. This is typified by heavy nighttime traffic to access the city's professional sport

*(continued on page 4)*



*Setting the cage*



*Free falling the concrete*



*Cages lining up*

venues such as the Denver Broncos NFL football team, the town's NL Rockies baseball team, and the shared NBA Nuggets Basketball and NHL Avalanche Hockey arena. This renders that 17-mile stretch very important to the vitality of the city.

While traffic delays are sometimes

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inevitable, by contract, the constructors cannot close any highway lanes before 8:30 PM during the life of the project. Three lanes of traffic must be maintained at all times. Needless to say the project goes on 24/7. Noise abatement is another major concern for those who reside or work along the 17-mile corridor. The noise level cannot exceed 78 decibels at night (90 dbs is the outside OSHA mandated limit that does not require special hearing controls). Specially

designed "Sound Trailers" which mute construction noise are strategically placed during construction on the existing street level adjacent to the lower elevation site being worked. The one concession granted is that the highway can be shut down after 9:30 PM when it is necessary to set bridge girders. Between the inevitable problems associated with construction such as noise, parking, and the ubiquitous mud, the stress on the PR team is constant. They appear to be up to the task. The project went so far as to provide 90%-of-cost-daily hotel vouchers for residents who did not want to put up with the "problems" when the construction advanced to their area of residence.

There are three distinct "publics" affected by this project. These are residents, travelers, and small and big business owners. T-REX goes right through Denver's vaunted Tech Center. The daily Hotlines, project website, "Open Houses", media support, direct-mail campaigns, traveling "Info-Vans," mobile noise-monitors to respond to citizen complaints and special liaison efforts with emergency responders, have resulted in begrudged acceptance of the inevitable dislocations. T-REX has clearly learned important public relations lessons from previous mega-projects such as Boston's Big

Dig, the Salt Lake City I-15 project, and the Alameda Corridor. The T-REX team is doing a far better job of preparing, informing, and quickly responding to public concerns. This serves as a "model" for how these kinds of projects should be approached in the future.

Now let us look at the design and construction aspect of T-REX. Anderson Drilling is working on a fast track scheme with its inevitable "design/re-design on the fly" problems. At the outset, CDOT provided 30% of the project drawings. The Kiewit-led JV took it from there. As previously mentioned, there is a very tight completion schedule. Anderson's work began December 2001 and is scheduled for completion in October 2003. In order to meet these demands, Anderson may have from 7-12 drilling rigs, not to mention service cranes, and ancillary equipment, working at any one time. It is sometimes necessary to "borrow" equipment from other company regional divisions. Anderson purchased three new rigs for the project. In order to achieve target production on a normal 5-day shift, Anderson is employing a variety of truck and crawler-mounted Watson\*, Soilmec\* and Spiradrill\* drilling rigs as well as crane attachments.

ADSC Technical Affiliate Member

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*Scrape away the excess material*



*Now you have it*



*Up close and personal*

**Bill Attwooll**, Terracon's Denver office, was responsible for much of the soil investigation, although CDOT provided the original boring information. Fortunately, Osterberg Load-Cells were used to develop and re-define design assumptions. CDOT specifications allow only for end-bearing in soil, but do allow for both skin friction and end-bearing in the rock sockets. Bill is very experienced with drilled shaft design and construction practices in the Denver area. This was a real plus for the lump-sum-bid project. Soils were only part of the challenge as the location of the myriad utilities along the 17-mile stretch created its own nightmare. At the outset the ever-changing design mode, plus necessary utility-location-stand-by time, and late-arriving concrete trucks, presented a major problem. As is frequently the case, a six-month learning curve helped surmount these initial difficulties. For those unfamiliar with Colorado weather, snow does not present nearly the problem that rain does for the construction phase. Snow having less moisture by volume is a preferable bad-weather condition than rain, which plays havoc with Denver's clay soil.

South Denver soils are well characterized and Anderson, like other local ADSC Contractors, are very familiar on how to handle the

### **Geotechnical Conditions** by Bill Attwooll

The I-25 T-REX project extends about 17 miles and includes the mainline of I-25 from Broadway just south of downtown Denver to Lincoln Avenue in Douglas County, and I-225 from I-25 north to Parker Road. The north end of the project alignment from Broadway to near University Avenue is within the geologic floodplain of the South Platte River. In this part of the alignment, up to 60 feet of alluvial sands and clays overlie the Denver Blue Shale, a competent siltstone/claystone.

Subsurface conditions along the remainder of the project alignment consist of surficial eolian and alluvial sands and clays over bedrock, typically found at 10 to 20 foot depth. The bedrock of the Denver and Dawson Formations generally consists of claystone with some sandstone interbeds. The upper portion of the bedrock is typically weathered and soil-like, becoming more competent with depth, but usually not as competent as the Denver Blue found in the South Platte River Valley.

### **Drilled Shaft Installation**

Along the T-REX alignment, as elsewhere in the Denver Metropolitan area, drilled shafts derive support by embedment in bedrock.

Relatively high capacity shafts can be obtained in the Denver Blue. Elsewhere, axial capacity is limited by the strength of the weathered bedrock materials.

Drilled shaft installation methods depend on groundwater conditions. Where bedrock is below saturated alluvium, casing is set into the top of bedrock. The casing is then cleaned out and the hole continued "in the dry" to design depth. Elsewhere, drilled shaft holes are usually drilled to design depth without casing. Water seeping into shafts is typically removed before concrete placement.

### **Osterberg Cell Load Tests**

As part of the T-REX project, five full scale drilled shaft load tests were performed using the Osterberg Cell (O-Cell) test method. Three of the tests were in the Denver Blue and confirmed the excellent available capacity. The two other test shafts were in weathered bedrock at the I-25/ I-225 Interchange and at County Line Road. At the interchange, the formational material N-values ranged from 30 to 90, with a gradual firming with depth. At County Line Road, the N-values ranged from 40 to 100, also with a gradual firming with depth. Pier design capacities were selected based on the load test results.

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*Location of utilities and proximity to the drilling site added to the challenge.*

drilling conditions. Anderson's contract called for drilling, "mudding," which is a local practice of using existing water as a slurry to aid in the installation of full-length casing. The contract also called for the placing and pulling of the casing, but not the placing of concrete, which Anderson would have preferred. The four different concrete mix designs included 4,000 and 5,000 psi concrete for

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both the dry and wet pours. Admixtures, including retarders, were specified. In the early stages the mix designs presented problems in and of themselves, with flash sets occurring due to the high cement ratio. This

too was worked out over time, and with experience.

The drilled shaft retaining walls installation contract call for 7,000 soldier piles with 18 to 78 inch diameters ranging from 15 to 75 feet in depth. There are to be approximately 500 drilled shafts installed for the bridge foundations. They will range from 18 to 96 inches in diameter and from 15 to 75 feet deep. All of the holes are "wet" with approximately 50% requiring temporary casing. The drilled shafts for the bridges include full-length reinforcing cages. All shafts will go to bedrock.

The total number of shafts and/or ultimate depths are paid by the linear foot, and in that the contract bid is based on units, the ultimate quantities could double as a result of the design-as-you-go aspect of the project.

Some of the added construction challenges include working with

very close tolerances due to restricted rights-of-way, utility location, and major concerns about wall deflection.

Much to their credit, Kiewit is training its design engineers to understand the complexities of constructibility-related concerns by bringing them to field sites, often by the bus load. According to Anderson's Denver Region Manager, **Mike Waldren**, "Anderson field personnel feel that this has helped the fast track project overcome some of the initial challenges." According to the contract, which includes heavy liquidated damages associated with meeting project milestones, the JV has to live with the CDOT specifications. This places a premium on cooperation between the designer, the general contractor, and the subcontractor.

**Lonnie Terry**, a long-time Anderson top-gun employee, is serving as the General Superintendent for Anderson's highly respected construction team. **Mark Foss** is the

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*The reinforcing cages were formidable*

Supervisor on the North segment, with **Steve Behrens** serving in the same capacity for the South segment. **Chad Allen**, an Anderson Project Engineer is also hard at work. He has been with the firm for only one year and he is putting his Construction Management Degree from Colorado State University to good use on this and other Anderson projects.

T-REX is moving ahead, on schedule, with the normal challenges associated with a project of this magnitude. All the pre-planning, cooperative mindset and public buy-in appear to have rendered this “monster” relatively “tame.” ■



*Access was challenging.*

## The T-REX Players

Project Owners: Colorado Department of Transportation and the Regional Transportation District

Joint Venture Partners: Kiewit Constructors and Parsons Transportation Group

General Contractor: Southeast Corridor Constructors

Foundation Drilling and Wall Subcontractor: Anderson Drilling, Denver, Colorado

Geotechnical Engineers: Terracon  
Kleinfelder  
Shannon Wilson

Structural/Design Engineers: Parsons Transportation Group  
Sverdrup  
DMJM  
Turner, Collie, and Braden

Drilling Equipment: Watson 2000 crawler mount (cm), 2500cm , 3000cm, 31000cm, 3100 truck mount,  
5000 crane mount  
Soilmec 312 (2), 518, R622  
Spiradrill  
Linkbelt 218

By the Numbers:

- 3 million square feet of walls
- 61 bridges
- 6 million pounds of structural steel
- 4 million cubic yards of earth excavated
- 27 miles of drainage pipe
- 575,000 tons of asphalt paving
- 456,000 cubic yards of concrete (this is enough concrete to build a 4-ft wide sidewalk,  
4 inches thick stretching from Denver to the White House)

For further information visit the T-REX website at [www.trexproject.com](http://www.trexproject.com)



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