# Optimal Trench Protection

## Key to Safety and Cost-Effectiveness

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## Introduction

The best possible trench protective solutions are critical to the success of underground construction projects and offer contractors a competitive edge they cannot afford to overlook.

The path to this objective is easy to follow and makes greater sense than ever before. New technologies have expanded choices for excavation support systems and added a financial incentive for using them. Unlike conventional trench protective methods that can add time and cost, these state-of-the-art technologies are designed to drive productivity and efficiency. Thus, the selection and proper use of optimal trench safety systems has become not only the right thing to do but also the financially sound thing to do.

Today, contractors, project owners and design engineers have new opportunities to learn about and receive guidance in selecting and using excavation support systems. However, a wide gap exists between trench safety innovations and available solutions, on the one hand, and an awareness of those solutions, on the other. Despite growing outreach and technological advances, the construction industry is only slowly beginning to grasp the importance of trench safety and realize the advantages of the latest in trench protective systems.

Contractors and other parties involved in specifying or implementing trench protection generally know that government regulations and community expectations require measures to safeguard trench workers. In addition, adjacent structures must be protected. These include utility pipelines, pavement, and building foundations. Yet, not all contractors have detailed knowledge of safety regulations for specific areas, and there is only a modest understanding of the broad array of protective options available. Traditional methods are not adequate for many of today's jobsites, and newer forms of ground support can boost productivity.

As a result, trenches that should have protective systems often have none, or are supported inadequately. What is more, when suitable devices are chosen, construction crews may not know how to install or remove them properly, so equipment may lie idle or not be used effectively.

The consequences resulting from the gap between product availability and use can be serious and costly. Trench accidents and deaths – most due to inadequate or no excavation support – have persisted at a roughly even pace for 15 years, the Occupational Safety & Health Administration (OSHA) reports. Worker deaths and injuries, as well as damage to facilities and structures, exact heavy emotional and financial tolls and can threaten business survival.

This white paper will help those involved in underground construction understand why it is necessary and beneficial to use the best trench protective systems. It also explains the merits of newer approaches, involving proactive

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shoring of trench walls. It is part of a broader, ongoing United Rentals initiative to provide the most cost-effective trench protective solutions, encompassing equipment, information, training, technical support and industry leadership. As North America's top supplier of trench protective systems and services, and the largest trainer of contractors in excavation awareness, the company has unique credentials to be a catalyst for improvement. United Rentals is collaborating with the private and public sectors to generate awareness, foster product innovation, and develop and promote best practices regarding trench protection.

Using statistics, examples and expert commentary, this paper examines the trench safety issue, focusing on current needs and solutions. It covers:

- Reasons for limited construction industry knowledge and use of leading-edge trench protection options;
- OSHA trench safety requirements, compliance trends, and liabilities of violations;
- Trench protective options, including active shoring systems: their advantages, shortcomings and factors for contractors and owners to consider in choosing the best solutions;
- Resources for information, training and assistance in selecting and implementing the most favorable excavation support systems.

### Reasons for Limited Awareness and Use of Newer Methods

Several factors help explain why the construction industry is only starting to become aware of and adopt innovative trench protective solutions.

Many contractors want to comply with safety regulations, but may be unaware of OSHA trench safety standards or individual state regulations. Or, if they are familiar with applicable regulations, they may not know how to interpret them for a given project. OSHA requirements, for example, allow contractors substantial leeway on the types of trench protection they can use.

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Even seasoned contractors may be unaware of newer protective methods and the benefits distinguishing them from older approaches. The notion that all trench protective systems unduly increase time frames and net costs still exists. In reality, the latest protective devices save time and money through faster, smoother installation and removal.

Other reasons for reluctance to invest in adequate excavation protection include: perceptions that trench accidents are rare or happen only to other people; and that safety regulations are not enforced aggressively.

Yet another cause of unfamiliarity with regulations and cutting-edge techniques relates to the evolving workforce. Increased spending and employment in the construction industry continues to attract new and often untrained people. These newcomers include immigrants who need to learn about U.S. construction standards and may face language barriers. In addition, workers moving between states or employers may have to become acquainted with variances in regulations and practices.

### Safety Requirements and Costs of Noncompliance

The OSHA excavation standard (*OSHA 29 CFR, Part 1926, Subpart P*) specifies when trench protective systems must be used and much more. Among its major provisions, the standard requires:

- Contractors to designate a competent person for each underground construction project. This person must conduct daily inspections of excavations, adjacent areas and protective systems; identify hazards; and act promptly to correct any problems;
- Adequate systems to protect workers be used for excavations unless trenches are entirely in stable rock and less than five feet deep and a competent person perceives no cave-in potential;
- All nearby underground facilities be located before digging, and that appropriate support devices be used to protect adjacent utilities and ensure stability of nearby structures;
- Contractors to test and classify soil and rock formations according to stability;
- Satisfactory methods of trench protection as defined in the standard;
- Contractors to develop, implement and enforce a comprehensive written safety program for all workers, including training in how to recognize hazards and avoid unsafe conditions.

In 20 states, designated state agencies supersede OSHA in setting and enforcing safety regulations, and often exceed federal rules. For instance, regulations in Connecticut and Massachusetts require that all employees working on

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government-contracted underground construction projects complete OSHA's 10-hour training program for competent persons.

It pays for contractors, owners and engineers to know and adhere to pertinent trench protection requirements. For several years, OSHA has put a heavy emphasis on trench safety. The initiative includes intense educational outreach and enforcement. In 2004, OSHA conducted more than 2,100 inspections of trench sites. As a result, it issued 4,132 citations and imposed penalties totaling nearly $7.6 million.

Besides OSHA and state fines, contractors and others involved in projects with safety violations face a multitude of tangible and intangible liabilities. Contractors can lose significant time and money through inspections, shutdowns, repairs and delays in obtaining proper protective systems, lawsuits, workers' down time, and employee replacement. In addition, construction firms' reputations are on the line, as trench accidents tend to draw heavy media coverage. Poor safety records can also cost construction firms opportunities to bid for municipal contracts.

Despite these downsides, awareness is beginning to have an effect. However, there is still a strong need for greater understanding and compliance. The number of trench deaths investigated by OSHA has remained between 50 and 60 for each of the past 15 years, or about one fatal trench accident per week in the United States. In addition, the agency records roughly 1,000 trench collapses a year that relate to lost-time injuries. While the percentage of OSHA-investigated trench incidents at jobsites without a competent person declined from 2003 to 2004, about two-thirds of jobsites inspected in 2004 still lacked such a person. Also, in a worsening trend, 88% of OSHA-probed trench accidents in 2004 involved sites with no protective system – up from 76% in 2003.

The relationship between injuries and an absence of trench support underscores the dangers of underground construction. Employees can die in unprotected

trenches that are as shallow as six to nine feet in depth. It takes only a small amount of soil to create enough pressure to asphyxiate a worker (a yard of dirt weighs almost a ton), and a person does not need to be completely covered in soil to die. Furthermore, it only takes seconds for a cave-in to become deadly.

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### Trench Protective Options

Technological breakthroughs are yielding new ways to secure trench walls. Compared to older systems, these new methods are better suited to today's site challenges. Innovations mean more information to digest, but also a greater likelihood of finding a solution that matches operational and financial needs.

Numerous factors should be weighed in selecting the best kind of system for a project. These factors can differ even within the same jobsite. Variables include: trench depth and width, soil type, the presence or absence of groundwater, operating space, construction access easements, proximity to existing facilities and structures, project schedule, project budget and equipment availability.

Trench support methods are grouped into three major categories, from least to most protective. Challenging conditions generally require greater safeguards. Rental or purchase costs tend to coincide with the degree of safety provided. On the other hand, installation and removal costs for some of the more protective measures are much lower than the alternatives, which offer less protection. The three major categories are:

- **Sloping/Benching** involves slanting the ground back from an excavation. This approach does not entail installing devices. It can provide sufficient protection for workers from a cave-in under certain circumstances. However, among its drawbacks: sloping does not safeguard nearby facilities or structures, requires significant space around excavations, and consumes extra time and money for site preparation and surface repair. The OSHA standard also restricts where sloping may be used, and specifies slope angles.
- **Shielding** is more cost-effective than sloping and protects workers better. Shielding devices are composed of two heavy steel or aluminum panels that stand against trench walls and are held apart by steel cylinders at the top and bottom. However, shielding does not safeguard nearby structure. It works best in relatively shallow excavations because of the difficulty and cost of lowering the devices into trenches. The most common example of shielding is a trench box, which is a passive protective system that allows soil movement, while the shield protects against cave-ins.
- **Shoring** offers greater protection than shielding, by means of plating held firmly in place with expandable braces. There are two principal kinds of shoring. The first is passive shoring, where the excavation is made prior to the installation of the shoring; examples are aluminum hydraulic jacks, screw

jacks and timber shoring. By contrast, active shoring is a newer class of trench protection where the shoring is installed prior to or during the excavation process and protects existing and above-ground facilities. Some examples of active shoring systems are beam and plate, slide rail, manhole brace systems, and sheet and brace systems.

With traditional passive shoring systems, workers can be injured while putting the devices in the ground during or after excavation. These systems react to earth movement rather than preventing it. The systems do not halt soil slippage that can threaten nearby underground and surface structures. They should be used only on sites where no existing structures need to be protected.

Active or positive shoring systems are installed before or during excavation. More effective than passive systems in poor soil conditions, active shoring devices proactively prevent soil from moving, protecting workers as well as adjacent facilities and structures.

**Active shoring devices proactively prevent soil from moving, protecting workers as well as adjacent facilities and structures. Slide rail systems, in particular, are gaining popularity.**

Active shoring is more appropriate than other methods for prevalent underground construction challenges such as poor soil, groundwater, deep excavations, tight spaces, route-crossing utilities, and long runs of large-diameter pipelines. Such technical considerations alone make active shoring the only viable solution for many projects.

Among active shoring alternatives, slide rail is gaining popularity with contractors due to its cost-effectiveness. Slide rail saves contractors substantial time and money because the system – comprised of steel panels that slide into tracked rails on vertical posts – is installed and removed quickly and smoothly as the earth is dug and backfilled. Light, modular materials also make slide rail easy to transport, assemble and disassemble, lower into deep trenches, and reuse within a jobsite.

Kiewit Construction Group, one of North America's largest construction firms, recently decided to rent a slide rail system from United Rentals rather than use its own shielding or beam and plate systems. Kiewit found that slide rail was best geared to a $30 million water pipeline project in Southern California. The project called for the installation of 40-foot-long pipe joints in 20-foot-deep trenches in soil that was rocky in places. Kiewit estimated that slide rail would enable it to lay pipes about 50% faster than its own pile and plate system, saving the firm about $7,000 to $10,000 per month in labor costs.

"We determined that the slide rail system from United Rentals was far superior to other systems we had looked at," said Willy Tsukada, Kiewit project engineer. "In addition, the service United Rentals was willing to provide was very important to us. We had quick turnaround requirements for receiving all materials at the site."

United Rentals recommends that all contractors and owners narrow trench protection options and perform cost/benefit analyses before construction.

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To aid these evaluations, the company has developed its own cost-estimating programs which enhance its ability to recommend the most cost effective solutions for customers. These diagnostic tools make it possible for customers to evaluate systems based on soil type, trench dimensions and other variables at the site, and compare the viability of up to four different system designs.

Every excavation has its own characteristics. A solution must fit an entire project, and a large job frequently requires a combination of protective systems. Therefore, specifications should allow as many types of systems as possible to accommodate diverse needs and conditions.

Contractors examining trench support alternatives also may want to consider whether to rent or purchase equipment. If the system will be in the ground more than three months, purchase can be more cost-effective. However, United Rentals, which both rents and sells trench safety systems, notes that purchasing, maintaining, handling, storing and having available inventory should be figured into the cost of ownership.

### Expert Resources for Training and Information

In navigating increasingly complex trench protection issues, contractors, project owners and engineers have many resources for training, information and other support. These sources include United Rentals, OSHA, NIOSH, and industry associations such as the Associated General Contractors of America (AGC) and the National Utility Contractors Association (NUCA).

United Rentals continues to draw on its expertise and emerging technologies to lead the movement for trench safety in North America. Collaborating with contractors, owners, engineers, manufacturers, industry associations and government agencies, the company is working to define and instill best practices; nurture and bring to market cost-effective technologies, tools and products; and broaden the industry's knowledge base.

"United Rentals is making a valuable contribution to improving trench safety industry-wide," said Patrick J. Coleman, chief of mining surveillance and statistical support for NIOSH, which has spearheaded the agency's trench safety education effort. "The company is a key source of safety knowledge, equipment and techniques for the construction industry. They are bringing awareness to a larger part of the industry by playing a major role in training, helping to develop best practices, and providing and promoting the best possible kinds of trench protection."

In a similar vein, Dee Stueve, safety coordinator for AGC and a master trainer for OSHA, said: "We partner with United Rentals because they are the experts in the field of trench safety. Whenever there's a problem on a construction site or a mock mobilization, we call them. They'll come out gratis to consult on a project or issue, develop a system, or refer us to an engineer if necessary."

Education is a top priority at United Rentals and its industry and government allies. The company trains 20,000 contractors a year in the OSHA Excavation Standard and plans to double that number over the next three years by offering standardized monthly training classes at all its trench safety locations in North America. United Rentals also trains OSHA inspectors; its customers, who receive product- and project-specific instruction; and company employees who assist customers through their branch network.

The company also arranged for one of its trench safety experts to be videotaped discussing best practices. The initiative is part of NIOSH's cost-effective, interactive training modules on CD-ROM and online, and may be utilized independently or in a classroom. In addition, NIOSH has produced a curriculum in cooperation with a United Rentals training consultant to offer information in multiple forms, including animation, video clips and slides.

"The training is starting to have an impact," Coleman said. "I hear comments like, 'Awesome! There's an incredible amount of information about safety techniques.' People also react to the combination of training styles. It sustains attention and offers something for everybody."

While trench safety advocates point to the increasing number of trainees as a sign of progress, they also agree that this is only the beginning. United Rentals is committed to helping raise the trench safety bar in an economical and innovative manner. Complementing its state-of-the-art training and information-sharing, the company works with manufacturers to enhance available systems; nurture emerging technologies; and pursue ways to promote the benefits of trench safety in underground construction to its customers and the industry at large.



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Additional information on trench safety is available at:

**OSHA:** www.osha.gov

**NIOSH:** www.cdc.gov/niosh

**AGC:** www.agc.org

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