Pipeline Accidents Raise Engineering Questions

BY JEY K. JEYAPALAN, PH.D., P.E

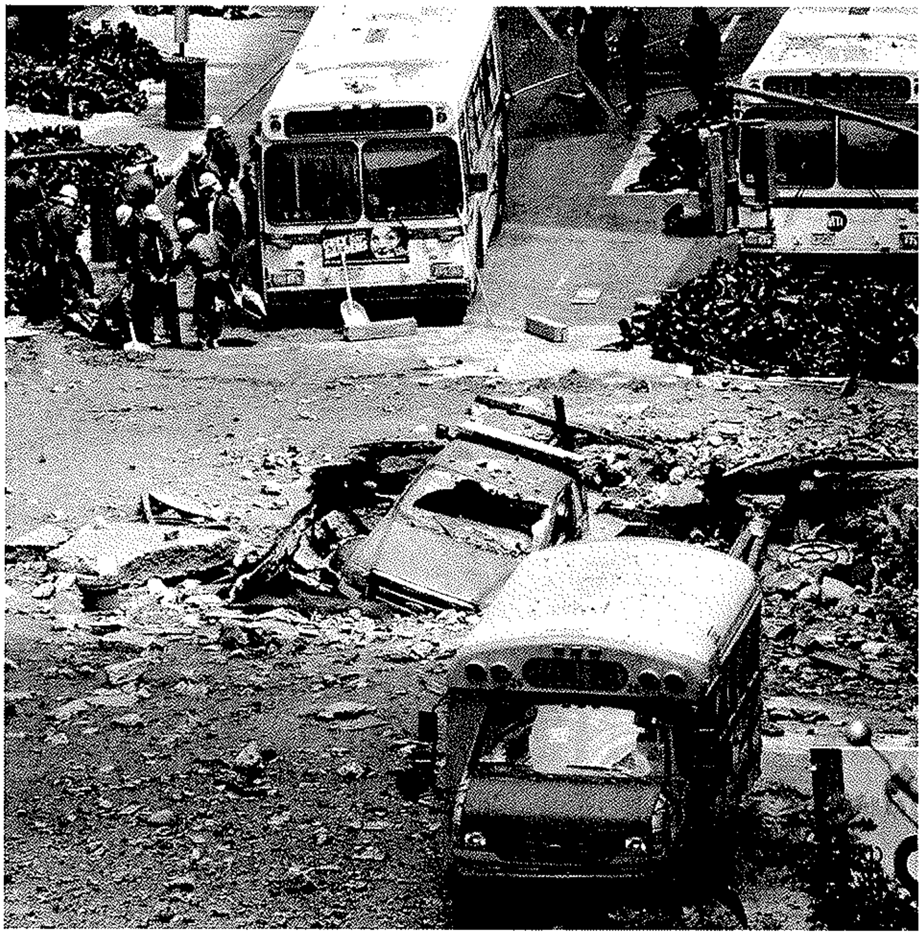
Last year, on July 18, an underground steam pipe explosion tore through a Manhattan street near Grand Central Terminal, swallowing a tow truck and killing one person, as hundreds of others ran for cover amid a roaring geyser of steam and flying rubble. Thousands of commuters evacuated the train terminal after workers yelled for people to get out of the building. The explosion of the 24-inch steam pipe installed in 1924 caused a brief panic about a possible terrorist attack, but Mayor Michael Bloomberg said, "There is no reason to believe whatsoever that this is anything other than a failure of our infrastructure."

Today there are more than 8 million miles of pipeline nationwide. It's a massive investment in infrastructure that comes with a troubling warning: the number of pipeline failures and serious accidents is on the rise.

In many cases, a contributing factor to pipeline disasters is engineering firm employees—sometimes including the assigned project manager—who are insufficiently qualified in either geotechnical engineering or pipeline engineering. When a pipeline is designed to be buried, it is extremely important that the design engineers have sufficient experience in these disciplines. Design, construction, and management of underground pipelines do not happen by accident.

In other cases, pipe vendors bring the technical know-how to these complex projects even though they may lack adequate engineering background, fail to consider all technical aspects of the job, and have conflicts of interest. This can lead a weak engineer to rely on manufacturers' data that when combined with poor engineering analysis can, in turn, lead to delays and cost overruns on projects that provide critical services to the public.

Bad projects that cost the public dearly and do not deliver the promised results can cause distrust of the civil engineering profession, as has happened in the electrical utility industry.



WORKERS CLEAN UP FOLLOWING A STEAM PIPE EXPLOSION LAST YEAR IN MANHATTAN.

PHOTO CREDIT: MARIO TAMA/GETTY IMAGES

Last year, over 40,000 major sewage spills and over 300,000 major water main breaks were reported. It's enough to make many Americans wonder whether the Centers for Disease Control and Prevention should step in to take control of this public health crisis. While the public may assume that many of these sewage spills and water main breaks are due to aging infrastructure, they are less likely to suspect that unqualified engineers, contractors, and inspectors have contributed to the problems.

Certainly aging pipelines are part of the problem, but age isn't everything. In some cities, like Seattle and Portland, Oregon, 100-year-old vitrified clay and cast iron pipes are still working well due to prudent asset management. At the same time, much younger prestressed concrete cylinder pipe has been falling apart at alarming rates, resulting in massive flooding. Civilians, construction workers, and property are all affected by these pipeline failures and accidents.

Why are pipeline failures and serious accidents on the rise? The most common causes of serious failures are

- Lack of formal classes and training in underground pipeline design, construction, and management in universities around the world;
- Inadequate understanding of the pipe-soil interaction principles by design engineers;
- Wide-ranging behavior of pipe materials;

- Claims and counterclaims of pipe manufacturers;
- Inconsistent design standards, sometimes by the same governing body, for different pipe materials;
- Political pressure brought on the engineer by pipe interest groups;
- Inappropriate and inadequate utility mapping during pipeline design or construction;
- Improper designs and inadequate pipe factory and site supervision by licensed engineers;
- Pipelines used well beyond their intended design life; and
- Improper operation and maintenance.

While there has been a dramatic increase in the volume of pipeline work, there is a severe shortage nationwide for engineers with sufficient experience in underground pipeline design, construction, and management. Universities need to offer classes in underground pipelines as part of their curriculum on all forms of transportation. The public and regulatory agencies also need to play a role by holding engineering firms more accountable and preventing them from leading underground pipeline projects when pipeline work is outside their core competencies. Contractors also need to be pre-qualified based on a track record of completing high-quality work without incidents.

By taking these steps, the number of pipeline accidents can be reduced and the credibility of the engineering profession can be improved.

Jey K. Jeyapalan, Ph.D., P.E., is the author of Advances in Underground Pipeline Design, Construction and Management. *He chaired the executive committee of the Pipeline Division of the American Society of Civil Engineers and was the founding chair of the ASTM International Committee F-36, writing global standards on underground utilities, cables, and asset management. He can be reached at jkjeyapalan@earthlink.net.*

Pipeline Accidents

Pipeline failures and serious accidents are on the rise. Here are some notable examples.

A fireball erupted when a backhoe operator hit the jet fuel line next to a trench in which an 89-inch water pipe was being constructed for East Bay Municipal Utility District in Walnut Creek, California. Three welders were burned to death while others were burned severely.

Prestressed concrete pipe used in a river outfall could not hold line and grade during installation due to the geotechnical engineer improperly plotting the borehole profile along the pipe alignment at the river crossing. The engineer also mistakenly represented that the bore was in a rock strata when, in fact, the contractor found weak native soils. Not checking for soil migration and specifying the wrong trenchfill material resulted in a change order of almost $1 million on a project that was originally contracted for $2.5 million.

Fiberglass pipe was designed for a sanitary sewer without much consideration of other pipe materials. Soil samples indicated organic material in the foundation for about 10% of the alignment. The design engineer recommended to the owner that steel sheeting be driven for the trench wall and be left in place for the life of the project, increasing the project cost from $1 million to $5 million. The owner, who paid for sound engineering decisions, told the engineer that this would be an unacceptable design and budget.

On a major pre-stressed concrete pipe rehabilitation project, the design engineer had neither experience with trenchless liners, nor had he reviewed data provided by the vendors. He recommended to the owner that the project be bid with an unsuitable liner material and demanded that all other pipe vendors refrain from contacting the owner about his decision. The design engineer did not consider any geotechnical data in the design.

An underwater inverted siphon with a 6-foot diameter to transmit water was designed with only one pipe material and without any serious consideration of alternate pipe materials. The siphon was supposed to be placed in a new 12-foot diameter tunnel and the annulus filled with an unprecedented amount of grout. The design engineer gave no consideration to sharing such an outrageously large tunnel with other utilities.

When a pre-stressed concrete pipe in a major regional water district began to explode, the owner turned to the pipe supplier and the design engineering firm for help. Both attributed the problems to the way in which the bends were designed. The independent consultant retained by the water utility, however, found deficiencies in the pipe design standards, the design specifications, and the bedding and backfilling specifications. The utility's consultant also found an additional major cause of the failures: the design engineering firm's pipe installation specification recommended placement of the bedding by flooding in highly expansive native soils. The design engineering firm then lobbied the utility's board of directors and pressured the water utility's engineering manager to switch the failure investigation and all further work to a new consultant who had already worked for the pipe supplier despite the clear conflict of interest. To date, millions of dollars have been spent on better design of the bends, long-term field monitoring, and the construction of risk curves when indeed the causes of the pipe failure had always been other factors, including gross negligence toward geotechnical data for the pipeline alignment.