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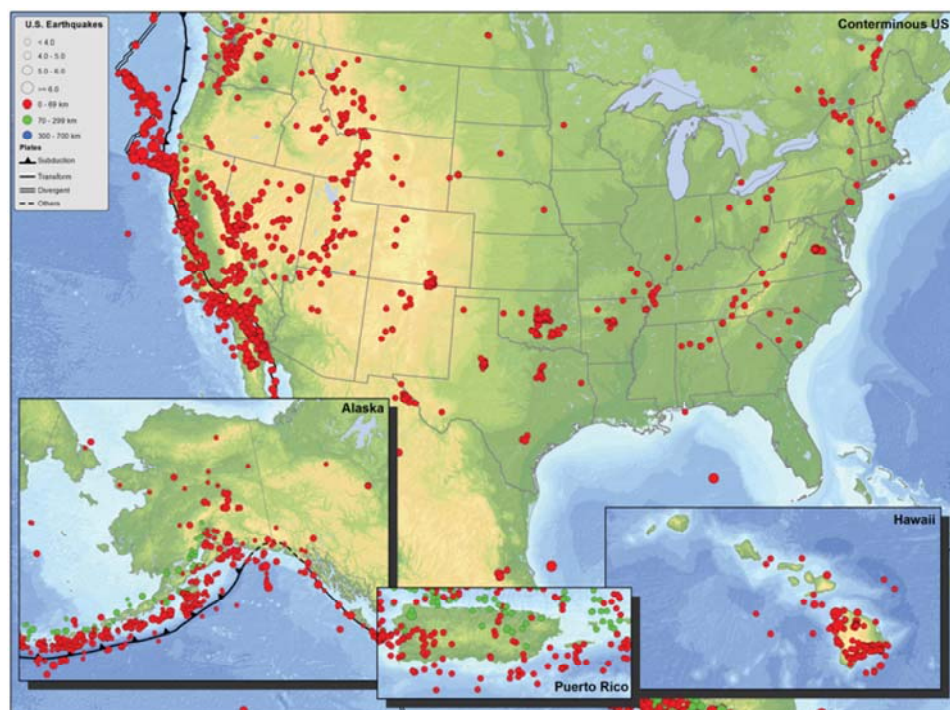


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# EPS Geofoam Protects Pipelines From Earthquakes

May 14, 2013 - Featured Stories



Seismicity of the United States from 1900-2002

## Who Says Big Solutions Can't Come in Lightweight Packages?

By Terry Meier

On Dec. 26, a gas pipeline blast followed by a mild earthquake struck Russia's Black Sea resort of Sochi, which will host the 2014 Winter Olympics. No one was hurt and there was no apparent damage to the city's infrastructure after a 5.2 magnitude earthquake was reported at 2:42 a.m. local time. According to the United States Geological Survey, there are 14,000 earthquakes worldwide each year that have a magnitude of 4 or greater — 700 of which occur in the United States and Alaska.

There are several methods for mitigating the effects of seismic activity on infrastructure, the most notable being the use of EPS geofoam as a seismic buffer for buried structures and rigid retaining walls. Six years ago, Canadian engineers Richard Bathurst, Saman Zarnani and Andrew Gaskin showed with shaking table testing and numerical modeling<sup>2</sup>, that geofoam could reduce the seismic forces on rigid retaining walls. The lightweight EPS blocks that have become ubiquitous with highway embankments, green roofs and landscape fill are growing in popularity for seismic and other buried applications.

Today the spotlight is shining on geofoam as a material with great potential for protecting pipelines. "If an earthquake occurs, high-pressure gas lines are one of the most important items to protect," claims Steven Bartlett, Professor of Civil Engineering at the University of Utah. "If they rupture and ignite, you essentially have a large blowtorch, which can be catastrophic."

Bartlett is associate professor of civil engineering at the University of Utah. He and his team have been examining geofoam's mitigating effects on pipeline damage due to seismic faulting since 2007.

Geofoam weighs roughly 1/100th of the weight of soil. "During the summer of 2007, Questar Gas Company requested that the University of Utah evaluate a conceptual EPS Geofoam cover system for a steel, natural gas pipeline crossing the Wasatch fault in the Salt Lake City valley," Bartlett says. "The fault rupture is expected to produce an earthquake with a potential magnitude of 7.5 and several feet of potential fault offset at the pipeline crossing."

If a major earthquake were to strike the Wasatch fault zone in the Salt Lake Valley, the fault

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displacement and the subsequent weight of shifting and compacted soil on buried pipelines is likely to cause them to rupture. Many buried pipelines lie under 6 to 8 ft of soil. Bartlett and his students at the

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**Pipeline Displacement Vectors During Large Ground Deformation**

The goal of a geofoam cover system on top of a buried pipeline is to reduce the lateral, longitudinal and vertical forces induced on the pipe as the surrounding ground undergoes deformation. The properties of geofoam have distinct advantages that lead to improved pipeline performance during large ground deformation.

There are two main advantages that geofoam has over traditional earth cover materials. First is geofoam's low mass density, which reduces the vertical and horizontal stresses on buried utilities and compressive soils. This reduction in loading and deformation will likely improve the performance of a pipeline during and after a major seismic event along the fault area. The second advantage of geofoam is its use as a compressible inclusion for systems undergoing static, monotonic and dynamic loadings. Geofoam is somewhat compressible and controlled compression can be used to reduce earth pressure against buried structures as well as deformation induced by structural loadings. Bartlett's team confirmed that the loadings that cause compression may include static and dynamic lateral earth pressure swells, frost heave pressures, settlements of support soils, faulting, liquefaction, landslides and traffic loads.

**A Lightweight Cover System for Pipelines**

In some cases the geofoam blocks are covered with a geomembrane. This membrane helps to reduce the vertical uplift stress by reducing the friction force between the geofoam and the trench sidewall. In addition, placing a geomembrane around the geofoam block will provide added protection against a potential petroleum spill.

EPS geofoam has been used for a number of large transportation projects in Utah. Geofoam proved to be an incredibly time- and cost-saving material for the embankments along Interstate Highway 15 in Utah. After realizing the benefits of using geofoam for I-15, UTA specified it for its TRAX light rail projects. At the same time it was used in the Weber Canyon and 3300 South pipeline replacement projects.

According to Bartlett, a new approach was taken to protect the 3300 South pipeline.

"Questar Gas had to put the pipeline right down the center of the roadway. When we looked at what other countries did, they built a trapezoidal geometry above the pipe — basically, just a wedge," Bartlett says.

Such a wedge would require many blocks of foam and would disrupt a large section of road. "This would have been a major problem in an urban area, as you might have to tear up 20 ft of lateral



The reduction in loading and deformation due to geofoam's compressibility will likely improve the performance of this Weber Canyon pipeline during and after a major seismic event along the fault area.

roadway. Try to do that for 3300 South — you'd have to shut the whole road down," Bartlett added.

Rather than gut a major thoroughfare, Bartlett proposed a "slot trench" design in which a block of geofam is placed in a narrow trench between a pipeline and the pavement above. In this design, if the pipeline begins to lift up, it will displace the geofam block and compress it. Although geofam is solid, it contains tiny air pockets that can compress without sacrificing the material's overall integrity. As the geofam is compressed further, it will slide upward along the trench sidewalls and could eventually damage the pavement above. "However, the pipeline will remain intact and essentially undamaged," he explained. Since the 3300 South project, Questar has been installing geofam to protect other natural gas pipelines in the valley and elsewhere.



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New research is being conducted to measure the effectiveness of geofam to help new buildings withstand earthquakes<sup>4</sup>. The use of geofam backfilling against a vertical structure significantly reduces and/or completely eliminates lateral pressure on that structure, whether it is a bridge abutment, retaining wall, or foundation wall. For example, with a foundation wall going 30 ft below grade, the compacted soil will create 3,750 lbs of vertical pressure at the wall base and 1,250 lbs of lateral pressure at the base of the foundation wall. The use of geofam will greatly reduce lateral and vertical pressure.

From "Numerical Investigation of

Geofam Seismic Buffers Using FLAC"<sup>5</sup>:

"In a typical geofam embankment such as that pictured above, the bottom-to-top layers consist of bedding sand, geofam block, reinforced concrete load distribution slab, road base (untreated base course), and concrete pavement. A prefabricated tilt-up concrete panel wall protects the geofam from damage and the wall is founded on an embedded slot footing. The panel wall is connected to the load distribution slab and a coping formed in the concrete pavement protects the panel top. An elastomeric material is placed between the coping and the panel top to limit the vertical and horizontal interaction at this point. In addition, the geofam blocks do not contact against the back panel wall.

"Typically, a 0.2-m gap is left between the geofam and the back of the wall to prevent interaction. However, continuous horizontal layers exist in the geofam mass, which can allow for interlayer sliding if horizontal seismic forces are sufficient to initiate it. No such vertical planes exist, because shear keys are used in which the blocks are staggered and the orientation is rotated 90 degrees on each successive layer. The bottom layer of geofam is placed directly against the slot footing of the tilt-up panel wall and is constrained from horizontal movement."

Geofam's light weight and compressive resistance makes it an ideal fill material for pipeline protection as well as highway embankments, landscape fill and green roofs. New information is pointing to its value as a potential seismic buffer for structural and infrastructure applications.

Terry Meier is ACH Foam Technologies' expanded polystyrene (EPS) representative, specializing in geofam. He was a participant in the Geofam Task Force for the I-15 project (the largest such project in the world) and helped introduce the material to Taiwan and the Philippines over the last decade. Contact him at [tmeier@achfoam.com](mailto:tmeier@achfoam.com).

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