Keeping Students Safe: Introducing the Monolithic Dome

By Carol Lanham

The tiny town of Niangua, Missouri, made national headlines in 2008 when a rare cluster of winter tornadoes tore across the state on an unseasonably warm January night. The twisters killed a Niangua woman in her trailer home and destroyed numerous other structures.

News photos of the trailer debris were a sobering reminder of the vulnerability of the town's youngest residents: preschoolers who regularly attended class in a double-wide trailer only one mile away.

Just a little over a year later, the town is making national headlines again, but this time the news is good. The Niangua R-V School District is building a revolutionary steel-reinforced concrete dome that will serve as the district's new preschool classroom and double as the town's disaster shelter. The building's unique shape and ability to offer near-absolute protection from tornadoes is noteworthy. But what gives this project national prominence is that the dome building is being constructed with a $300,000 grant from the Federal Emergency Management Agency (FEMA).

The project's federal funding is sparking hope among superintendents in other disaster-prone school districts that more government money may soon be in the pipeline to fund what is known as predisaster mitigation efforts. Those are funds earmarked to help a community *before* disaster strikes, and could become more of a priority in the Obama administration.

"During the Clinton years, the focus was on predisaster mitigation and the mantra of the time was that $1 spent on mitigation saved $4 on recovery costs," says Bill Waugh, who teaches disaster management at Georgia State University. "Bush changed the focus first to terrorism and then to response, which led to the end of what was called the Disaster-Resistant Community program. All indications are that the Obama administration intends to go back to the more proactive approach focused on predisaster activities and making communities better able to respond."

If that prediction proves true, Niangua could serve as a useful case study of how other districts could apply for grant funding, but also of how the money could be put to the best use after the grant is awarded. The town's qualifying for the FEMA grant under the Bush administration also illustrates that, regardless of presidential policies, it is possible for school districts to qualify for federal funding. However, the community must meet FEMA's risk and needs criteria, and the grant application should be spearheaded by someone with enough determination and persistence to navigate the requisite red tape.

Overcoming Hurdles

In Niangua, which is located in Webster County, Missouri, Linda Watts, the county's assistant emergency management director, did most of the legwork for the grant. She started the process in 2005 by documenting the town's history of natural disasters, along with their frequency and devastation, in a national hazard mitigation analysis. The analysis showed that tornado activity in Niangua surpassed the national average by 26%.

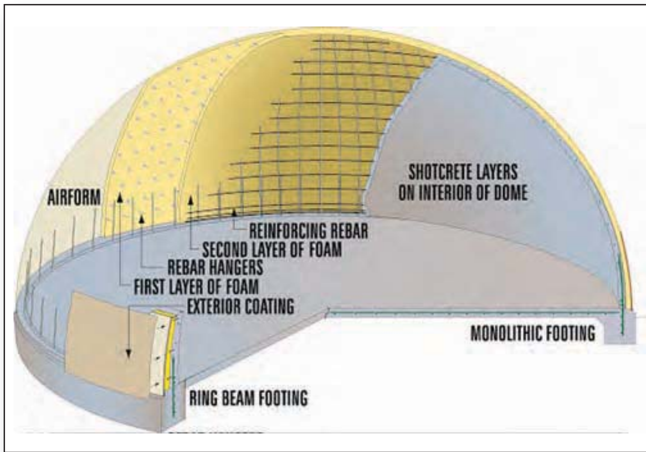
The next step was to prove the community's financial need. With a population of fewer than 500 people, a high unemployment rate, and relatively low tax revenues, Niangua easily qualified as an impoverished community. The grant application then had to go through a review process at the state, regional, and finally national level, where a 10-member FEMA panel voted on its merits.

Butch Kinerney, a spokesman for FEMA's mitigation department, estimates that the FEMA panel votes on about 450 such grant applications every year, and only about 80 to 100 are actually funded. Of those, just 12 to 20 are school projects.

"We like to see schools used as storm shelters," Kinerney says. "And it's a big honor to have a community that is able to clear all the hurdles and meet the series of specifications that have to be met."

Niangua appeared to have cleared all the hurdles in 2006 when it qualified for a FEMA predisaster mitigation grant of $313,000 designed to cover 90% of the construction costs for a new building. But when the project went out for bids, school officials found that there was one major hurdle still left to clear. "It went up for bid the conventional way, and every single bid came in well over the limit. We thought we were going to have to give back our grant," Watts recalls.

Then, Niangua Superintendent Andy Adams remembered seeing a brochure about unconventional dome school buildings that met FEMA standards for near-absolute protection from tornadoes. In fact, the buildings—known as Monolithic Domes—were touted for withstanding winds of up to 300 miles per hour (100 more than required by FEMA). They were also described as energy efficient and less costly to build than a conventional structure. After doing further research, Adams and the school board were sold.



Turning to the Dome

David South, who coinvented and patented the process for building Monolithic Domes and now heads the Monolithic Dome Institute in Texas, was among those who talked to Adams about the benefits of a steel-reinforced concrete dome school building that could double as a community disaster shelter.

"It's difficult to construct buildings that can withstand a direct hit by tornado winds," explains South. "Block walls have a heavy mass, but tornadoes can push with 100 to 400 pounds of pressure per square foot, and conventional walls typically cannot withstand that kind of pressure."

In contrast, the curved, steel-reinforced concrete walls of a Monolithic Dome can withstand pressure of up to 2,000 pounds per square foot, South says. This attribute has been confirmed not only by the institute's consulting engineers but also by anecdotal evidence, including the fact that domes have been built 30 feet underground where the pressure can reach one ton per square foot.

"Concrete in a curved shape reinforced with rebar naturally becomes stronger than any other building built," says Arnold Wilson, professor emeritus of civil engineering at Brigham Young University and a consulting engineer for the Monolithic Dome Institute. "I have personally engineered approximately 1,400 Monolithic Domes in nearly every state and many foreign countries. Many of them have been subject to hurricane forces and a few to tornado forces, and all have withstood these forces in an excellent manner."

FEMA agreed that the buildings were safe and approved the use of a Monolithic Dome for the Niangua school district. Even better, the grant money paid for 90% of the building's construction. That's because a Monolithic Dome typically costs less to build than a conventional building of the same size. Niangua chose a general contractor that ensured the project came in within the budget.

Under Construction

Once construction began, school officials discovered that the method used to build Monolithic Domes is as unusual as the buildings themselves. The process begins with the placement of a ring beam footing and the pouring of a circular steel-reinforced concrete slab floor. In many cases, a stem wall is then erected to give the building straight walls and a more conventional look. Next, crews attach an Airform, a tarp made of tough, single-ply roofing material, which is inflated using giant fans.

Once the Airform is inflated, work moves to the interior, where treated wood is attached to frame the windows and doors. Three inches of polyurethane foam is then sprayed on the rest of the Airform, and a grid of steel rebar is attached to the foam. In the final step, crews spray on a layer of shotcrete that ranges from four inches at the top to eight inches at the base. The result is a permanent and virtually indestructible structure.

Because the insulation is between the Airform and the concrete, which lines the interior and has thermal properties that help it maintain more constant temperatures inside the dome, Monolithic Domes can cost 50% less to heat and cool than traditional buildings of the same size. "The energy savings along will usually pay for the total cost of the structure within the first 20 years," says Monolithic Dome Institute's David South.

In Niangua, school officials are not waiting on the energy savings to cover the 10% of the construction costs not covered by the grant money. A portion of the funds has come from the city and county, and the school district's share is largely in sweat equity. "I, along with a couple of others, did all the painting on the inside of the dome and we're going to do the floor tile," says Adams, the superintendent. "We're doing everything we possibly can to get this building ready."

Worth the Work

Despite the building's novelty for the town and many of those who have heard about the project through the news media, the dome school in Niangua is actually not the first Monolithic Dome school to be built in Missouri. That honor goes to Pattonsburg, which built four domes to house students in kindergarten through 12th grade in 1998. Dome schools or university buildings have also been constructed in Rockport, Caldeonia, and Parkville, Missouri, as well as in 11 other U.S. states and seven countries around the world.

But Niangua is the only school district in the nation to have its Monolithic Dome funded by FEMA, which even a spokesman for the agency concedes is no small feat. "It's a lot of hoops to jump through," says FEMA's Kinerney. "But at the end of the day, if you are able to save lives, it's worth it."

Carol Lanham has worked for the Associated Press, Reuters and *Newsweek*. She now is with Dallas-based BWG Agency and writes frequently on the topic of Monolithic Domes. Email: carol@bwgagency.com. Freda Parker contributed to this article.