

Buddha Statue

By Peter Epperson

It was 2015, and I was imagining retirement. I had been a shotcrete contractor for almost 40 years. My company, Pacific Gunite, had primarily worked with thin shell concrete and ferrocement since 1986, and for those 40 years, we'd been building ferrocement water tanks for some of the thousands of people on our island who depend on rain catchment for their water supply. I had always loved the



Fig. 1: Concept design of statue and interior support



Fig. 2: Head on steel frame

job, but working in an area that averages over 180 in. (4600 mm) of rain per year has special challenges (never mind living on an island where 18-year-olds take early retirement, presenting significant labor challenges). But then I got a call from a local Buddhist monastery: They asked if our company would build them a 110 ft (34 m) tall concrete statue of the Buddha. It would be the tallest statue of Buddha in the Western Hemisphere. How could I say no? I forgot all about retirement.

Ferrocement is almost unknown in Western countries. It has a reputation for being labor intensive, but that is an unfortunate and inaccurate assessment: The water tank construction technique we employ is relatively quick and easy, and a much more affordable alternative to conventional concrete tanks. Our designs don't usually follow the exact definition of ferrocement. I prefer the term "Thin Shell Concrete". The idea is the same — there is a much higher steel-to-concrete ratio than in typical concrete construction. Our 60,000 gal (230,000 l) tanks have a wall thickness of just 2 in. (50 mm).

The monastery had no design for the desired statue, just a concept. After two years of design, engineering, and permitting, we began construction. Planning began with the purchase of three different 3D models of the Buddha. Elements of the three models were combined to design the statue that the monastery envisioned. Working with a couple of engineer friends (T.P. Singh of Construction Research Technologies in Delhi and Ray Keuning in Hawaii), we created the design of the structural components of the statue.

Above our 15 in. (380 mm) thick concrete foundation, we decided on a solid 4 in. (100 mm) thick concrete floor every 10 ft (3 m) in elevation and a 12 in. (300 mm) thick central concrete core that also extended from grade to the top. Concrete posts, beams, and shear walls supported the floor slabs.

We discussed how we would shape the exterior for some time until I saw a YouTube video that showed a CNC plasma cutter in action. Using our 3D design software, it was simple to define section drawings, or profiles, anywhere along the statue's exterior and turn those shapes into files that the CNC cutter could work with. Plates of 5 ft x 10 ft x 0.25 in. (1.5 m x 3 m x 6 mm) stainless steel were cut to shapes 1.5 in. (38 mm) wide, and each piece was numbered. Then, like a giant puzzle, the vertical pieces were welded to anchors embedded in the concrete floors, and horizontal profile pieces were added to the verticals. A stainless steel wire mesh was added to the inside and outside of the profiles to complete the armature. The final total wall thickness for the exterior of the statue came to no less than 2.5 in. (65 mm).



Fig. 3: Adding mesh to armature

Concrete for the entire exterior of the statue was hand mixed for better control and to alleviate scheduling concerns with ready-mix delivery of concrete.

The monastery requested a statue that would last for 1000 years. As long as the statue gets a new coat of paint every 25 years, I think that it will. We used MMFX reinforcing bar for the floors and core structure. The concrete mix was 4000 psi (28 MPa) with Cortec anti-corrosion additive, silica fume, and 6 lb/yd³ (3.5 kg/m³) of PVA fibers. Our aggregate was crushed basalt, which is inherently very strong. Our core samples always tested well over the 4000 psi goal, and many samples were over 10,000 psi (69 MPa). We hand mixed all 30,000 ft² (2800 m²) of the exterior of the statue with the same mixture of sand only and no coarse aggregate. All steel other than the MMFX rebar was 316 stainless steel.

The earlier pours on the lower floors were the largest, and we used a boom pump. Upper floors were placed with a Schwing 750 line pump or a small Reinert 536 pump. The exterior spraying of the statue used a Putzmeister peristaltic squeeze pump. We have always used peristaltic pumps for our thin-shell concrete surfaces. They can be turned down low for spraying thin layers or to a higher RPM for pumping up to 1 in. (25 mm) of material. Even though it is considered a low-pressure pump, the Putzmeister had no problem pumping up to the 110 ft elevation. It's a low-volume pump with a maximum output of 8 yd³ (6 m³) per hour at a 4-in. slump. At the nozzle there is minimal pulsing and very smooth shotcrete spraying.

As each 10 ft level was completed, work to create the armature for the exterior began. The vertical stainless profiles were welded to anchors cast into the floor slabs.



Fig. 4: "Condor" manlift

Horizontal profile pieces were then welded to the verticals every 30 in. (750 mm) to both stabilize the armature and help define the shape. A layer of 0.5 in. (13 mm) welded wire mesh was attached to the inside of the armature and a layer of 0.25 in. mesh to the outside. If more detail was needed anywhere, additional steel rods were added to the profile pieces. For areas where there were many tight curves, we would use woven mesh instead of welded mesh to maintain the desired shape. We would shotcrete a reinforcing layer of concrete inside and out to cover the steel. The final finish coat would come later.

Most of the statue was finished directly onto the structural framework. Because of the detail required for the head of the statue, and because of its elevation, we decided to create the head on a steel frame on the ground and lift the finished pieces with a crane. Due to the location of the statue being in a very rainy location, a removable 30 ft² (2.8 m²) 'umbrella' covered the steel framework space where we would build the head.

The head was comprised of nine separate parts, which were bolted together on our ground-level frame. Upon completion, they were lifted into position at the top of the statue, where each piece would then be bolted through the floor and welded to steel brackets previously cast into the concrete floor slabs. In addition to the face, the back of the



Fig. 5: Armature with mesh and 0.375 in. steel rods for better definition and finished mortar layer

neck, and the two ears, we also had to make the five parts that comprised the top of the head, or scalp, which included 400 curls. These curls have symbolic significance, and presented their own challenge, as they couldn't be created with our CNC cut armature approach.

There were 16 different size curls. We made a separate polyurethane mold for each size curl. Each curl had steel reinforcement with exposed tabs that could be welded to the larger section of each of the five scalp parts. Our Rhino 3D software once again proved invaluable when we needed to calculate the weight and center of gravity for each piece to create appropriately sized lifting frames for the crane. A Grove 50-ton (45 tonnes) crane had no

problem positioning all of the parts.

Lifting all of the parts that make up the head and fitting them into their final positions was obviously something that required careful planning. In any construction project, surprises can happen. When you have an expensive crane on the job, one might expect to be concerned and even lose a little sleep. We initially anticipated two days to complete the first lift that included the face, both ears, and the back of the neck. As it turned out, things went flawlessly, and we were done by lunchtime the first day! As the pieces were lifted to their final positions, I looked toward the ground and saw several monks looking up with their hands in prayer. Perhaps success depends on more than just calculations



Fig. 6: Hands, before and after



Fig. 7: Lifting parts of the head



Fig. 8: The completed statue

and planning. There were two more crane days as the other parts of the scalp were completed. They also went smoothly.

Fortunately, the monastery located a military surplus manlift with a 125 ft (38 m) reach and load capacity large enough for our project. This beast was essential in aiding scaffold erection as well as helping people get to those hard-to-reach places that needed work. Finding the perfect tool at an incredible price was just one of the many pleasant surprises that came along with this job, and it will continue to earn its keep with occasional cleaning and maintenance after construction.

Like the head, the hands were also built on the ground level. With everything ready, it was time to finish and place the hands. We called the crane back for a final lift. Then, as a finishing touch, a series of 12-ft (3.6 m) lotus petals surrounds the base of the statue. Fiberglass molds of the lotus petals were made and the petals were shotcreted with our concrete mixture one at a time. Touchups at the seams gave the surround a clean, homogenous look. The concrete portion of the project was now complete. Two coats of polyurethane paint were then applied over the entire surface.

The statue was completed in 2024 after 7 years of construction, mostly by seven of my employees and three monks from the monastery. The monks took on some of the more arduous tasks: One of them ran the CNC cutter and produced a few thousand pieces of the steel that shaped the statue. Another monk became the daily project coordinator. He also painted the entire statue by himself. A third made the fiberglass molds that were used to create the surround at the base of the statue.

I had many workers come and go, but a core group stayed with the project to completion. My crew, which were primarily concrete placers and finishers at the beginning of the job, left with some new skills. Four of them are now also certified welders, and they all handled enough formwork lumber that they could join a carpenters' union.

My retirement has finally arrived, and this statue was my swan song. Although I take some credit for this accomplishment, I was never one of those that had to erect scaffolding in the rain or deal with the myriad of things that can go wrong while mixing and pumping and placing concrete. What a job!



Peter Epperson owned and operated Pacific Gunitite on the big island of Hawaii from 1986 to 2024. The company always valued the creative potential of concrete, often taking on challenging projects and preferring to take a carefully considered chance rather than declining an offer for fear of failure. Peter is retired now, but two of his sons operate their own concrete businesses

in the area. They carry the tradition by building lifetime water tanks, swimming pools, and other imaginative creations.