FLEET OF STONE

Concrete has been a novel hull material for 150 years.

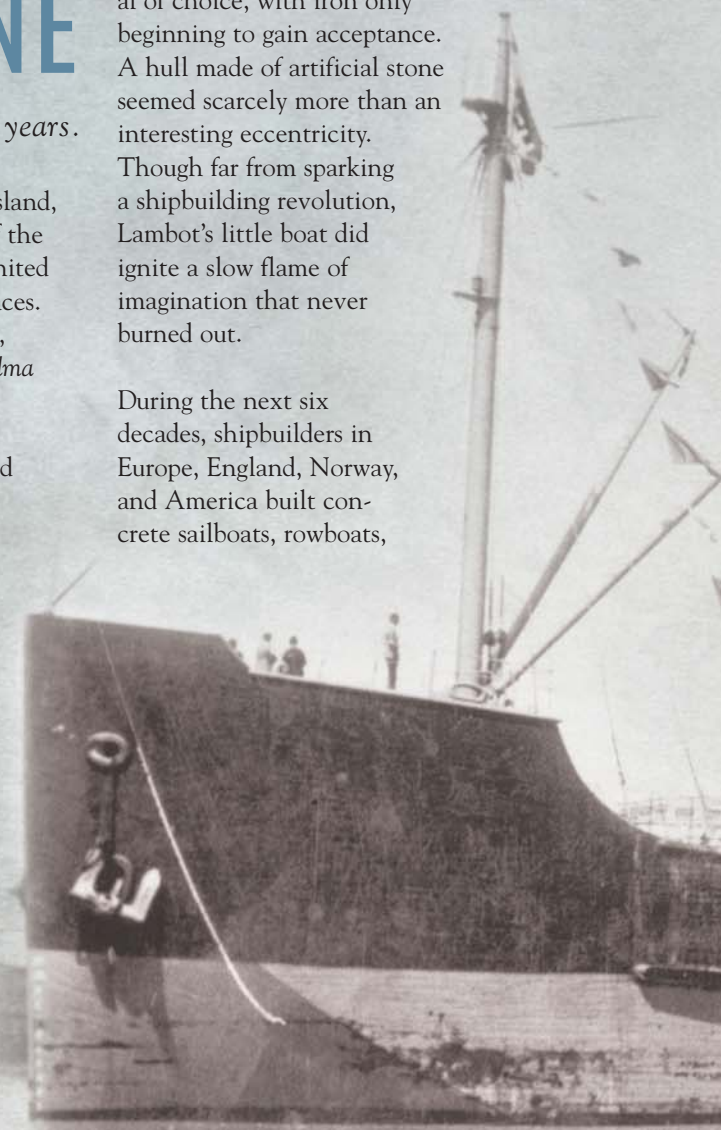
Just off the eastern shore of Pelican Island, near Galveston, Texas, stands one of the more peculiar monuments on the United States' National Register of Historic Places. It is the largely intact hull of a stranded, ancient oil tanker the SS *Selma*. The *Selma* has been distinguished with an official Texas Historical Marker granted by the Texas Historical Commission, designated a State Archaeological Landmark by the Texas Antiquities Committee, and honored as the official flagship of the Texas Army.

Oddly, the *Selma* is neither a Civil War veteran nor a Texas ship, nor even afloat. Launched out of Mobile, Alabama in 1919 and abandoned two years later, she has been stuck on her lonely perch for 82 years, her decks nearly awash at high tide. Thanks to the dedicated work of her owner, retired Texas newspaperman and historian A. Pat Daniels, the lonely ship has received a renown that she never enjoyed in service. Capping her list of distinctions is that *Selma* is one survivor of a small sorority of very special curiosities, the 36 reinforced concrete steamships built in the United States during World Wars I and II.

Reinforced concrete has been a novel shipbuilding material for a very long time. Concrete strengthened by iron bars was patented in 1848 by French inventor Joseph Monier – who, it is said, was seeking to build a better flowerpot – and within a few years was on its way to acceptance as a material for small building construction. The public's first mass exposure to concrete hull technology came in 1855 at the Universal Exposition in Paris, where visitors were greeted by a reinforced concrete rowboat built by Joseph-Louis Lambot.

Though Lambot's creation won kudos for novel use of new technology, it failed to commercialize the concrete hull. Wood was still the shipbuilding material of choice, with iron only beginning to gain acceptance. A hull made of artificial stone seemed scarcely more than an interesting eccentricity. Though far from sparking a shipbuilding revolution, Lambot's little boat did ignite a slow flame of imagination that never burned out.

During the next six decades, shipbuilders in Europe, England, Norway, and America built concrete sailboats, rowboats,



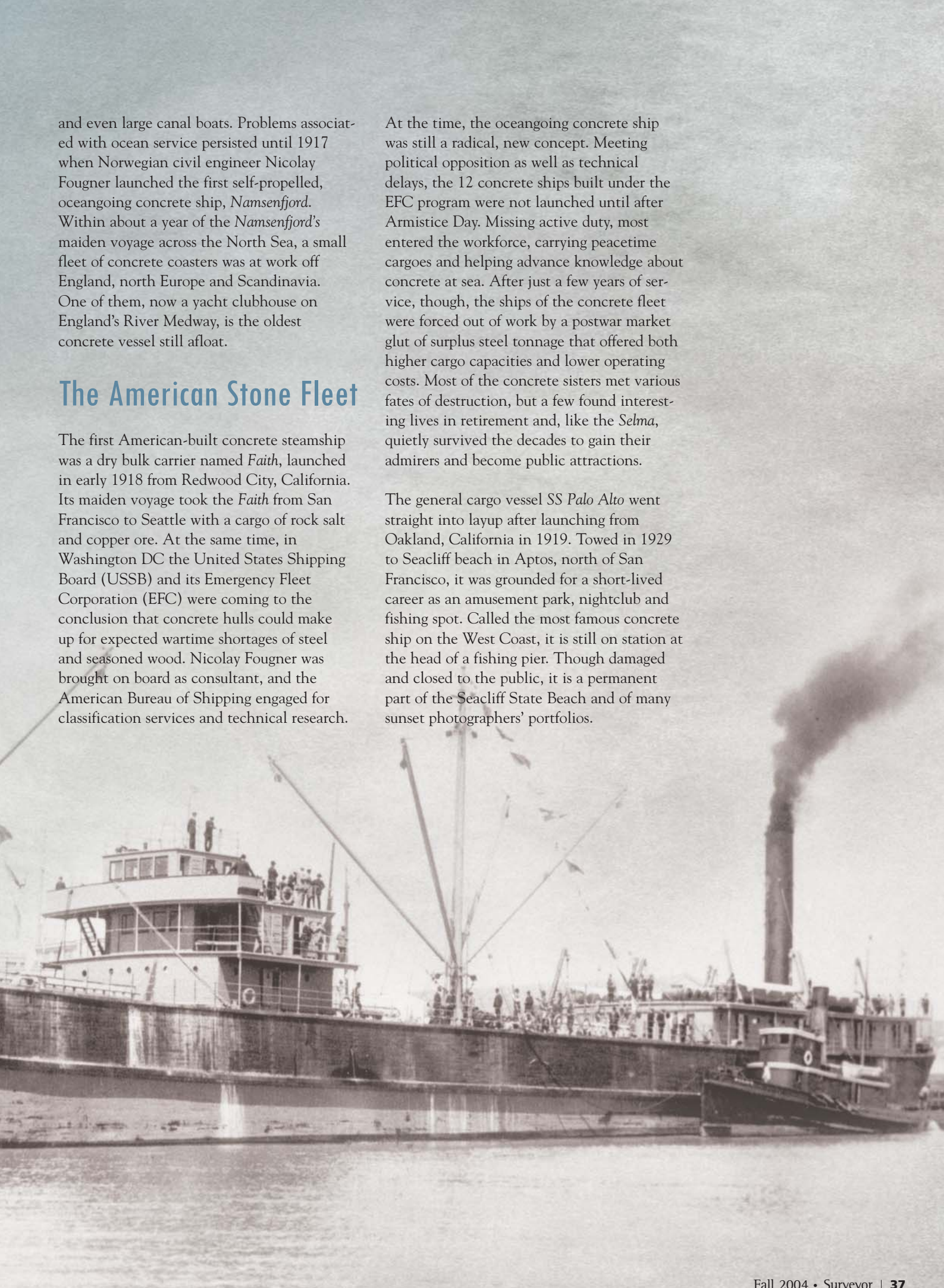
and even large canal boats. Problems associated with ocean service persisted until 1917 when Norwegian civil engineer Nicolay Fougner launched the first self-propelled, oceangoing concrete ship, *Namsenfjord*. Within about a year of the *Namsenfjord's* maiden voyage across the North Sea, a small fleet of concrete coasters was at work off England, north Europe and Scandinavia. One of them, now a yacht clubhouse on England's River Medway, is the oldest concrete vessel still afloat.

The American Stone Fleet

The first American-built concrete steamship was a dry bulk carrier named *Faith*, launched in early 1918 from Redwood City, California. Its maiden voyage took the *Faith* from San Francisco to Seattle with a cargo of rock salt and copper ore. At the same time, in Washington DC the United States Shipping Board (USSB) and its Emergency Fleet Corporation (EFC) were coming to the conclusion that concrete hulls could make up for expected wartime shortages of steel and seasoned wood. Nicolay Fougner was brought on board as consultant, and the American Bureau of Shipping engaged for classification services and technical research.

At the time, the oceangoing concrete ship was still a radical, new concept. Meeting political opposition as well as technical delays, the 12 concrete ships built under the EFC program were not launched until after Armistice Day. Missing active duty, most entered the workforce, carrying peacetime cargoes and helping advance knowledge about concrete at sea. After just a few years of service, though, the ships of the concrete fleet were forced out of work by a postwar market glut of surplus steel tonnage that offered both higher cargo capacities and lower operating costs. Most of the concrete sisters met various fates of destruction, but a few found interesting lives in retirement and, like the *Selma*, quietly survived the decades to gain their admirers and become public attractions.

The general cargo vessel SS *Palo Alto* went straight into layup after launching from Oakland, California in 1919. Towed in 1929 to Seacliff beach in Aptos, north of San Francisco, it was grounded for a short-lived career as an amusement park, nightclub and fishing spot. Called the most famous concrete ship on the West Coast, it is still on station at the head of a fishing pier. Though damaged and closed to the public, it is a permanent part of the Seacliff State Beach and of many sunset photographers' portfolios.



The *SS San Pasquale*, an oil tanker launched 1921 in San Diego, traded for a year before becoming a molasses store ship in Havana, Cuba. Run aground close offshore northern Cuba in 1933, she lay forgotten until World War II, when the hull was fitted with machine guns and cannon as a guard post against U-Boat attack. During the Cuban Revolution, it served Che Guevera as a prison for captured partisans. In the 1990s, the ageing veteran began welcoming voluntary guests in her present form, a ten-room hotel off the resort town of Cayo las Brujas.

The *SS Peralta*, launched in 1921 from San Francisco, left the tanker trades in 1924 for a quarter-century in the fish trades, first as a reduction plant in Alaska and then a floating sardine cannery offshore California. Today the last of the WWI ships still afloat, she is part of a ten-ship floating breakwater in British Columbia's Powell River. The other nine links of this massive chain, protecting a paper company's log pond from the ravages of the Pacific Ocean, belong to the second concrete fleet, built during World War II.

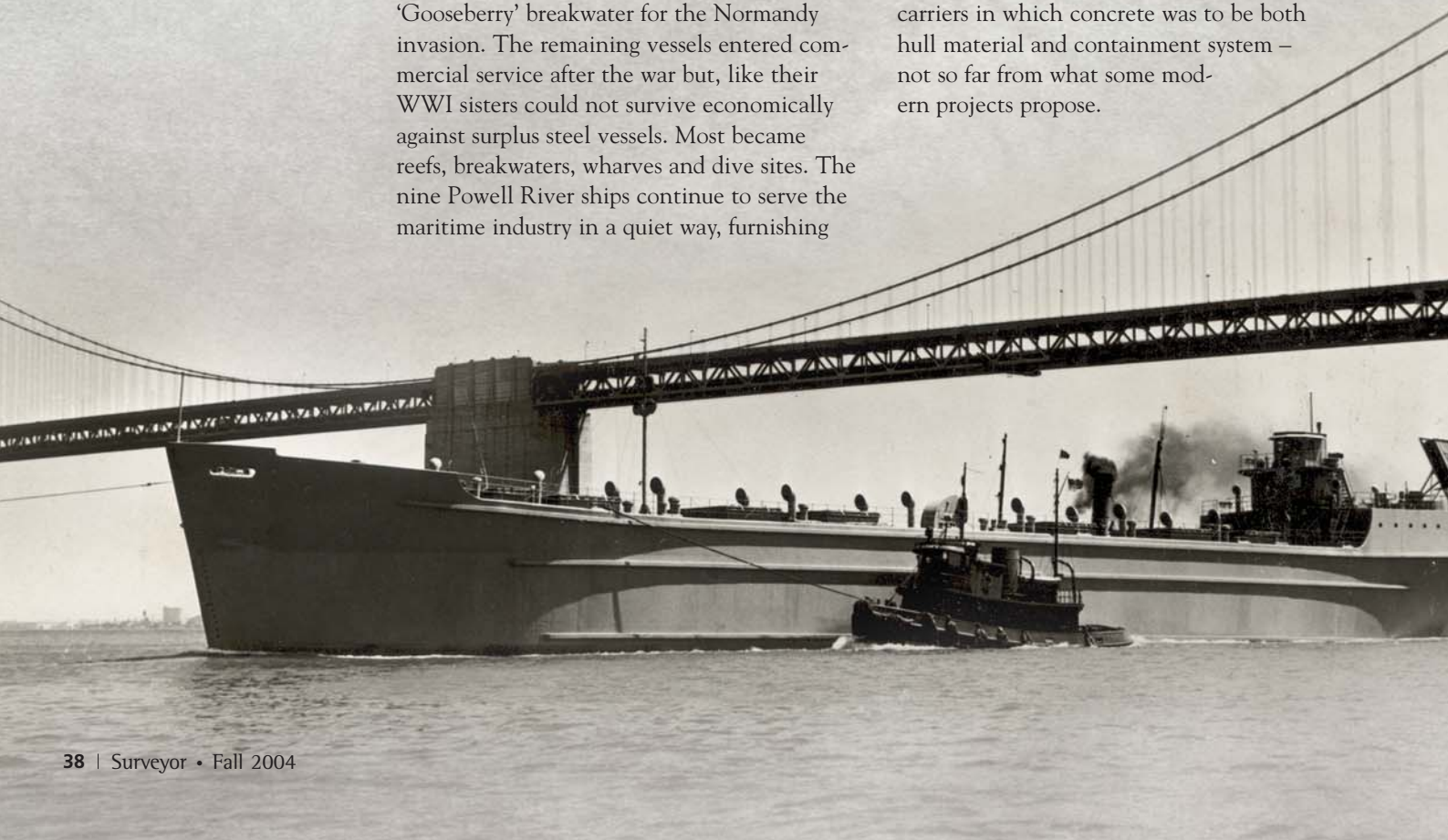
Better formed of higher-technology concrete, the 24 ships and around 80 ship-shaped barges of WWII racked up noteworthy service in very tough weather and proved exceptional in resistance to fire and bomb hits. Foreshadowing the fate of nearly the entire concrete fleet, two of the ships were sacrificed to make the 'Gooseberry' breakwater for the Normandy invasion. The remaining vessels entered commercial service after the war but, like their WWI sisters could not survive economically against surplus steel vessels. Most became reefs, breakwaters, wharves and dive sites. The nine Powell River ships continue to serve the maritime industry in a quiet way, furnishing researchers useful information on the durability of reinforced concrete in maritime applications.

A few years ago, Chicago-based Concrete Technologies Laboratory was asked to examine four of the Powell ships to determine the effects on concrete hulls of long-term exposure to extremely harsh environments. Visual inspection and laboratory tests of core samples revealed, "the concrete is of exceptionally good quality and overall is in excellent condition."

Concrete Future

No large concrete ships have been built since World War II, but concrete barges continue to serve all over the world and there continues to be an active worldwide trade in concrete houseboats, sailboats and other pleasure craft. Over the past decades, concrete has found application in other maritime sectors, most prominently offshore energy development as a hull material for drilling platforms and storage and production barges.

In 1975, for example, the 60,000-dwt ABS-classed *Ardjuna Sakti* floating concrete LPG storage facility was installed in the Java Sea. While proving the utility of concrete hulls for floating cryogenic storage systems, it did not help realize contemporary proposals for LNG carriers in which concrete was to be both hull material and containment system – not so far from what some modern projects propose.



The sheer mass, strength and durability of reinforced concrete have made it the ideal choice to protect drilling and production platforms against ice impact in Arctic offshore environments, often as gravity-based structures (GBS). A cheap alternative to artificial islands, a GBS is floated out and ballasted into place, the concrete hull acting as anchor, island, and protector of the platform. In 1984, for example, a huge concrete 'brick' of a patented honeycomb structural design, the ABS-classed *Glomar Beaufort Sea*, served as the base for the innovative Concrete Island Drilling System (CIDS) developed by Global Marine Development for drilling in Alaska's Beaufort Sea.

There are also floating concrete public works. Among the earliest projects was the first floating concrete container terminal, installed at Valdez, Alaska in 1984; among the latest proposals, afloat runways for San Francisco and Oakland airports.

With novel additives and creative reinforcement materials giving it a seemingly unlimited potential for adaptation, concrete continues to be the stuff of visions for dreamers, designers, engineers and eccentrics. Three years ago, the mechanical engineering and aerospace department of the University of Alabama at Huntsville managed to launch a small rocket with a graphite-reinforced concrete hull. Four years ago, a novel offshore design proposed a concrete production spar 120 ft wide and 774 ft long. Several years before that, Russian engineers developed a design for a concrete submarine, the 'C-Sub,' marketing it – with its own weapons system – as a cheap means for poor nations to develop an undersea defensive capability.

Among the incubators of advanced concrete technology is the national concrete canoe competition held annually in the United States. Far from being a pageant of eccentrics, it is a showcase in which engineering universities compete on canoe design and performance using ever newer, lighter, and more durable concrete materials. To win the 2001 concrete canoe competition, for example, the Hunstville team used the composite-reinforced concrete formula of its rocket hull to create a flexible canoe that could surge forward between strokes and 'swim.' They were able to lower the natural frequency of the hull so that the paddlers could drive it toward resonance; the hull deflects during the stroke, storing elastic strain energy that, after the stroke, is transformed into a forward propulsive force. The achievement reportedly attracted interest from the US Navy.

Clearly, even if no more concrete cargo ships are ever built, the potential in this basic building block of the modern world has by no means been exhausted.

Photos from the National Concrete Canoe Competition.