A Bridge to a Composite Future

by Jessa Netting

A barrage of natural and man-made forces threaten bridges, from the imperceptibly slow degradation of salt water, corrosive soils and heavy traffic to the sudden catastrophic destruction of earthquakes. Southern California mercilessly serves up all these onslaughts, challenging the creativity, imagination and ingenuity of structural engineers. One of these technological visionaries is Frieder Seible, chair of the department of structural engineering at the University of California at San Diego. During the next two years, Seible and his team, along with the California Department of Transportation, will undertake an ambitious project to fabricate the world's longest cable-stayed bridge having main structural members built from fiberglass, carbon and other unorthodox construction materials.

Designed to connect two sections of the U.C.S.D. campus, the bridge will stretch 450 feet (140 meters) over Interstate 5. In place of sober concrete and impassive steel, much of the 60-foot-wide structure will begin as filaments of glass, carbon or gold-toned aramid (a lightweight polyamide material). The delicate black or translucent strands, which look like pieces of yarn made of thousands of twisted fibers, hardly seem capable of supporting the weight of a four-lane bridge. But their delicacy belies hidden properties. According to Seible, these composite materials can be up to five times lighter and stronger than structural steel (the actual strength depends on fiber orientation). Just as important, the materials are largely inert. Unlike steel, they do not corrode in the presence of moisture or salt, nor do they suffer from water seepage that can freeze and enlarge cracks in concrete.

But these synthetic composites carry premium prices. So to stay within budget, the Seible team will also use some cheaper, traditional materials such as concrete. After all, Seible says, "We don't want to build a gold-plated bridge." As planned, the project will still require about $11 million, up to twice the cost of a comparable conventional bridge. The added expense should be mitigated over time, however, by the structure's increased durability and lower maintenance.

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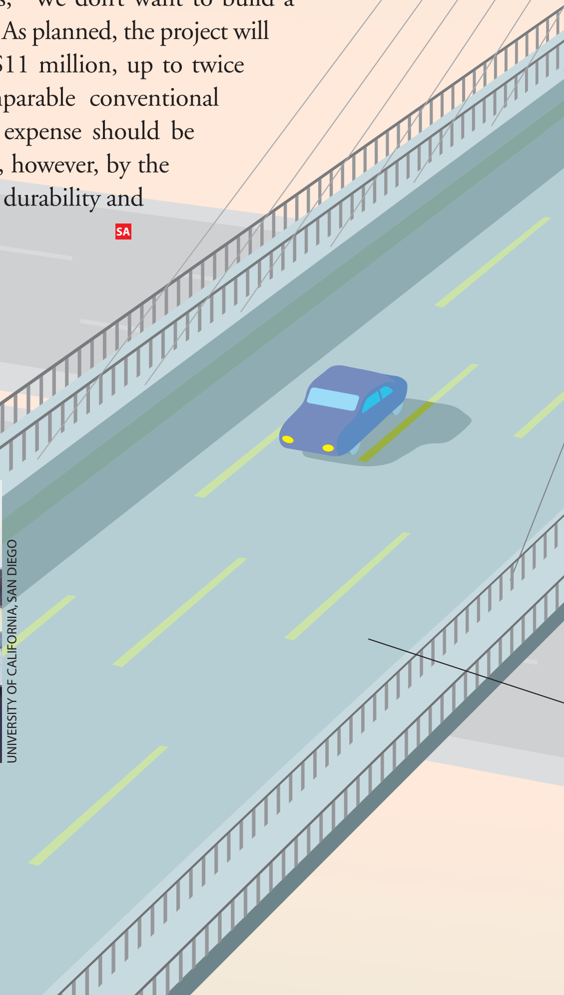

ILLUSTRATIONS BY BRYAN CHRISTIE

DECK SYSTEM: Arched forms (*right*) are made from lightweight polymer concrete, onto which fiber-reinforced concrete is later poured. Transverse tubular beams, fabricated by epoxying individual sheets of glass and carbon-fiber fabric, will support the deck. The stirrups shown will transfer lateral forces, such as those from earthquakes or wind, from the deck to the beams.

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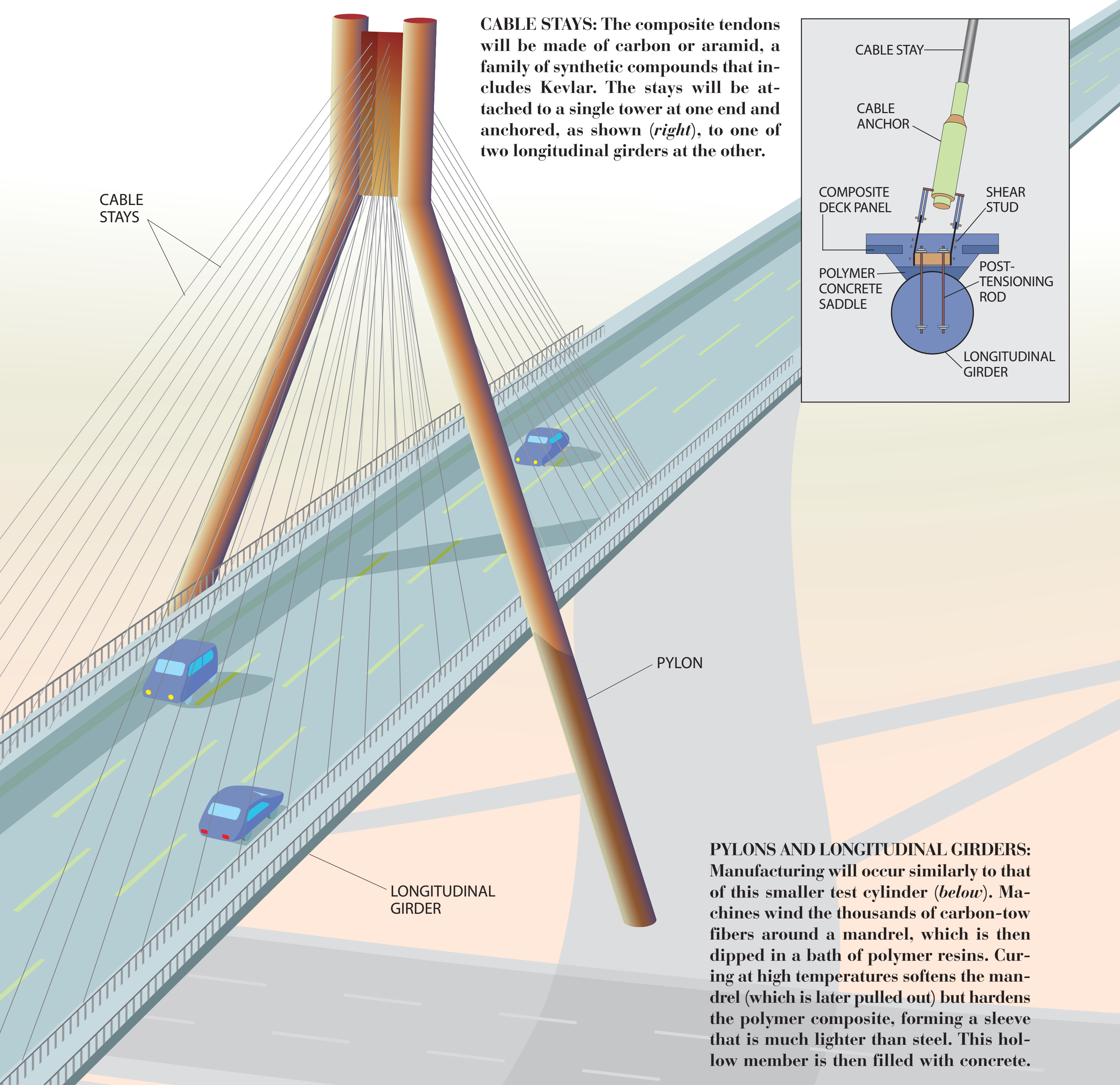
CABLE STAYS: The composite tendons will be made of carbon or aramid, a family of synthetic compounds that includes Kevlar. The stays will be attached to a single tower at one end and anchored, as shown (*right*), to one of two longitudinal girders at the other.



PYLONS AND LONGITUDINAL GIRDERS: Manufacturing will occur similarly to that of this smaller test cylinder (*below*). Machines wind the thousands of carbon-tow fibers around a mandrel, which is then dipped in a bath of polymer resins. Curing at high temperatures softens the mandrel (which is later pulled out) but hardens the polymer composite, forming a sleeve that is much lighter than steel. This hollow member is then filled with concrete.

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