Hybrid Composite Beam

What is a Hybrid-Composite Beam (HCB)?

The HCB is a sustainable technology that combines the strength and stiffness of conventional concrete and steel with the lightweight and corrosion resistant advantages of fiber reinforced polymers (FRP). As a structural system, the HCB is not a plastic structural member as virtually all of the strength and stiffness of the beam is derived from concrete and high strength galvanized pre-stressing strand. Safety is inherently built into HCBs and the strength capacity has consistently exceeded code requirements (confirmed by full scale testing). By optimizing the inherent qualities of the three components (FRP shell, compression reinforcement and tension reinforcement), the HCB allows construction professionals to build better structures that are cost competitive, stronger and require no additional training for their crews.

The Origin of the HCB

The underlying concept of the HCB was conceived by Mr. John Hillman, PE, SE in the mid 1990's. Mr. Hillman, a bridge design engineer supposed that if a concrete arch were tied at the ends and encapsulated in a FRP shell, that the embodiment would become a structural member that would be lightweight, strong and corrosion resistant. During the next ten years, Mr. Hillman embarked on a journey that would take him through the mathematical modeling of the concept, various small scale prototypes and testing. After small scale prototypes proved successful, full scale, 30 ft long beams for designed for Cooper E-80 railroad loading, were tested. Again, the tests proved the concept. The next step was to develop a commercially viable fabrication process to build and test under real world conditions a 30 ft railroad bridge. During 2006 and 2007, the process was developed, the beams fabricated and shipped to the Transportation Technology Center (TTCI) in Pueblo, Colorado. On November 7, 2007, the first known Hybrid Composite Railroad Bridge was tested under live railroad loading consisting of two locomotives and 28 fully loaded (320,000 lbs each) gondola cars. Once again, the beams performed according to the model developed and refined over the years by Mr. Hillman.

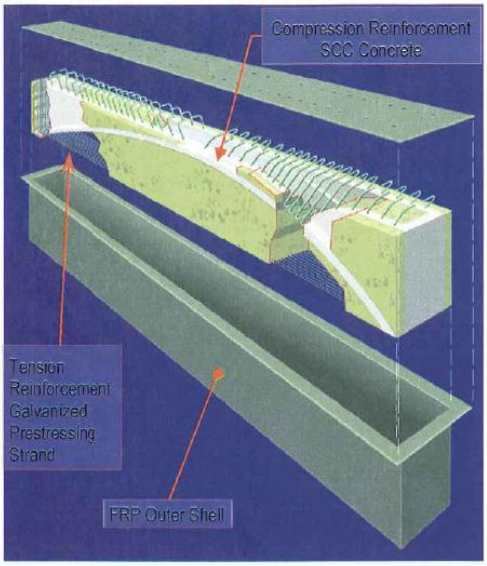
Since then, two highway bridges have been built using the HCB, one in Lockport Township, Illinois in 2008 and one in Cedar Grove Township, New Jersey. The third highway bridge, the 540 foot long, eight span Knickerbocker Bridge in Boothbay Harbor, Maine, is being fabricated and it is expected to be erected starting in the fall of 2010. Other projects include highway bridges for Missouri's Safe and Sound Project, marine piers, a railroad bridge designed for revenue service on a Class I railroad, and green roofs are in the planning or design stages.

What the HCB Changes and/or Replaces

The HCB is designed to make efficient use of FRP composite materials to be a lightweight, corrosion resistant structural member. The HCB can be used in most applications where structural steel or pre-stressed concrete beams are used. While it changes the life expectancy of structural members and offers more options in construction methods due to its light weight, there are other benefits as well. Since the HCB uses a combination of FRP, concrete and steel, less quantities of concrete and steel are required, resulting in a smaller carbon footprint required for the manufacturing of these materials. The ability to transport several beams on one truck and the use of smaller cranes minimizes the carbon footprint even more. Also, the closed mold, vacuum-assisted resin transfer method (VARTM) used for manufacturing the composite shells is an environmentally friendly, zero VOC emission manufacturing process.

Just as important, the HCB in and of itself does not mandate any complex or new design criteria or changes in construction methods.

INNOVATION ILLUSTATION
HYBRID-COMPOSITE BEAM

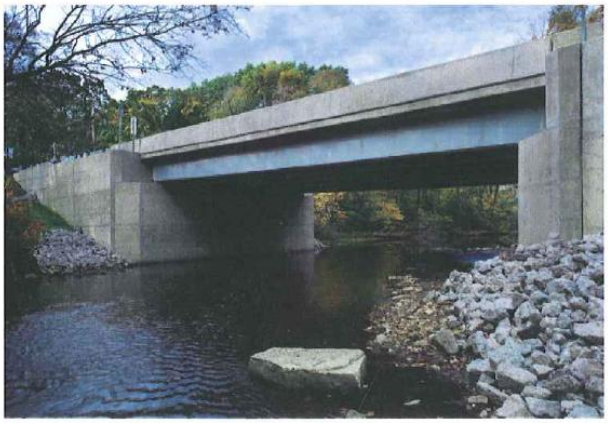


HOW THE HCB WORKS
The HCB is an embodiment that uses a concrete arch (compression reinforcement) tied at each end with a tension tie (tension reinforcement) encapsulated in a FRP shell. This provides a lightweight structural member that is strong, corrosion resistant and requires minimal maintenance

NOVEMBER 7, 2007
John Hillman (HCB Inventor) stands beneath the first installation of a Hybrid Composite Railroad Bridge at TTCI in Pueblo, Colorado

HCB Prefabricated Railroad Bridge Module being lifted into place by an RT Crane. Two of the 6'-6" wide by 30'-0" modules completed the span →

RECENT HIGHWAY PROJECTS



HIGH ROAD BRIDGE, LOCKPORT TOWNSHIP, ILLINOIS
This bridge consisted of six (6) HCB's 58'-4" long x 42" tall with a conventionally formed cast-in-place concrete deck.

NJDOT—ROUTE 23 OVER PECKMAN'S BROOK, CEDAR GROVE,

The six (6) beams (32'-0" long) comprising one phase of construction are delivered on one truck. There are five (5) beams are 6 ft wide and the 3 ft wide beam (on top) is for the sidewalk →

← The 2,000 lbs beams are off-loaded two at a time and then set in place using a small excavator. All six beams were set in less than 4 hours.

Phase 1 complete in August 2009, Phase 2 was set in October 2009 and opened to traffic in November 2009