Use of Continuous Fibers for Reinforcing

by Takayuki Hirai

In Japan continuous fibers are being used both in actual practice and experimentally as prestressing tendons, reinforcing bars, and mesh, for both new construction and retrofitting. The materials being used have high performance and durability characteristics not available with conventional steels. In his article in the August 1992 issue of Concrete International, Koichi Minosaku described the use of fiber reinforced materials in prestressed concrete. This article focuses on the use of such materials for non-prestressed reinforcement.

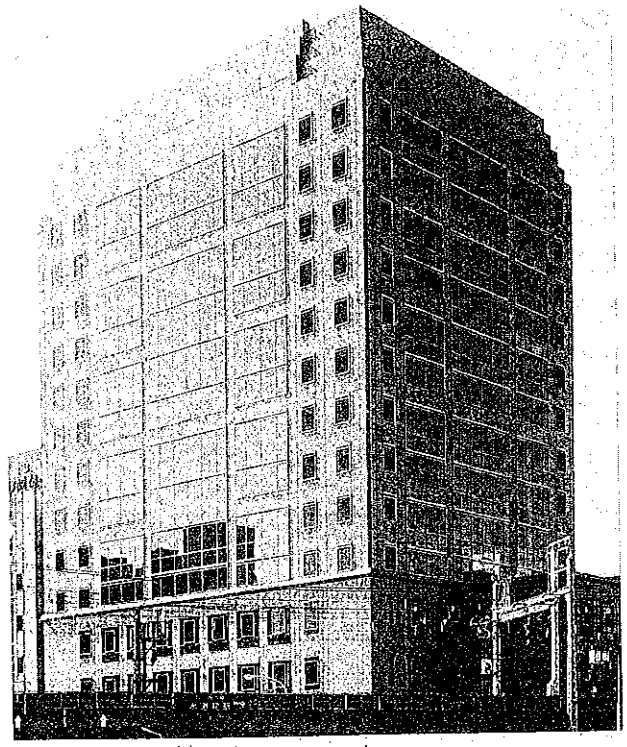
Reinforcing bars

Continuous fibers are being used for reinforcing concrete where long-term durability against corrosive solutions and gases is demanded, where non-magnetic properties are desired, and where ease of transporting, cutting, fabricating, and placing of reinforcement is needed.

Continuous fibers can be made into preformed reinforcement assemblies that can be cut into complex shapes. Because of its light weight, such reinforcement can be placed in formwork without the use of machinery such as winches. This is extremely useful where mechanical facilities are limited and where there is a shortage of skilled workers, since even in these situations construction time can be reduced and quality improved.

The photographs accompanying this article show a variety of uses of various types of continuous fiber reinforcement in concrete in Japan. Also shown is use of the material in the three-story main administration building at the Showa Base in Anarctica.

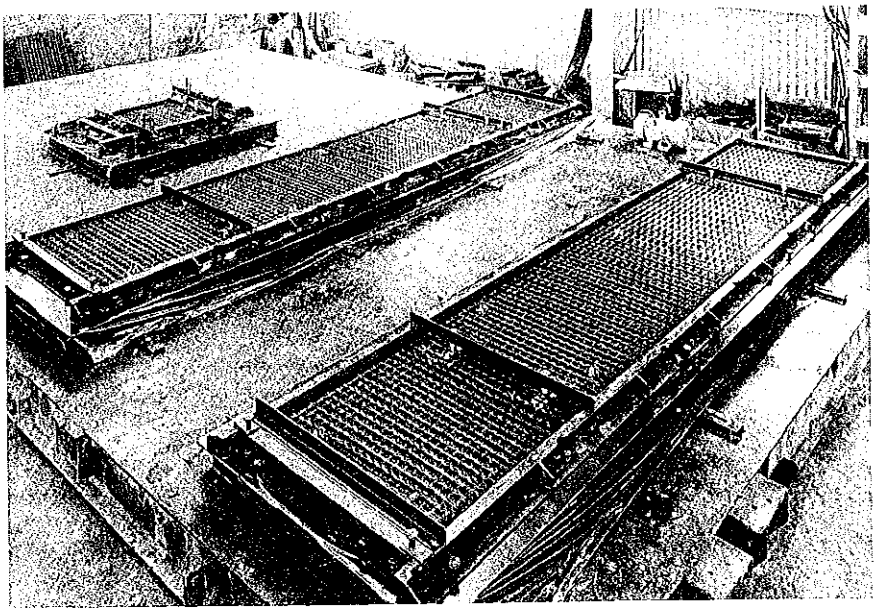
Rods made of vinylon fibers and polyarylate fibers bonded together with epoxy resin are being used to reinforce concrete walls and floors. Some rods have plain surfaces, others have twilled, deformed surfaces. Other products are available such as accordion shapes for use as stirrups and twisted wires. Spiral filament-wound fiber reinforced plastic rods made of carbon, glass, or aramid continuous fibers bonded together with vinyl ester resin and having the same variety of fiber wound around and bonded to the rod to produce a deformed surface have also been developed.

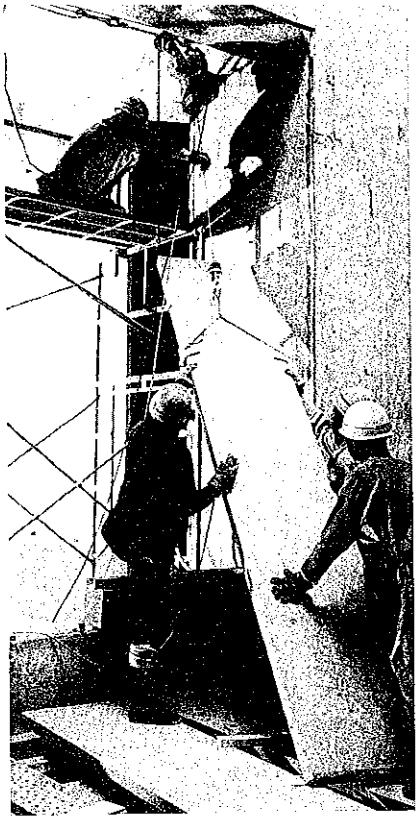


The parapet panels on the Tokyo Dental College Suidobashi Building are reinforced with bars containing continuous aramid fibers.

The lightweight concrete curtain wall panels of this building are reinforced with grids of carbon and glass fibers bonded together using vinyl ester resin.

Concrete





The photograph at left shows concrete panels being prefabricated using continuous fiber reinforcement. The photo above shows these panels being installed in a partition wall for a chlorine storage room at Higashi Murayama Water Purification Plant.

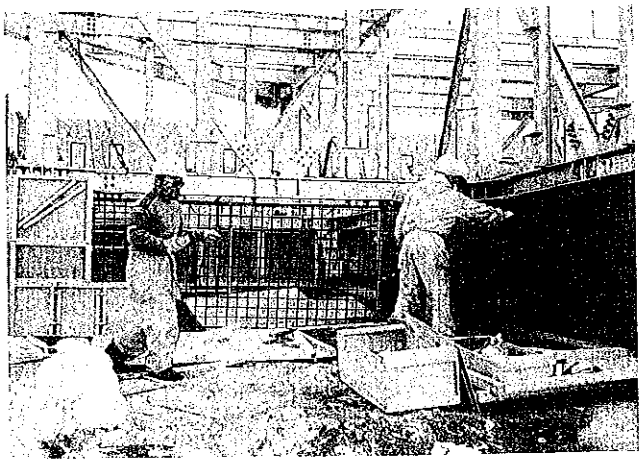
Mesh

Wire mesh is being made from continuous fibers of aramid, carbon, and glass braided into tape and impregnated with resin. Vinylon mesh is being used for reinforcement in both concrete and cement secondary products.

Retrofitting

Structures can be retrofitted with continuous fiber reinforcement by bonding fibers directly to the surface with resin, or by attaching a fiber-reinforced prepreg product.

Continuous fibers are being used in this way to improve flexural strength, shear strength, ductility, and fatigue restistance, reduce deflections due to cracking, and prevent cracking due to thermal stresses. They are also being used to prevent wall finish materials such as tiles from falling, by covering

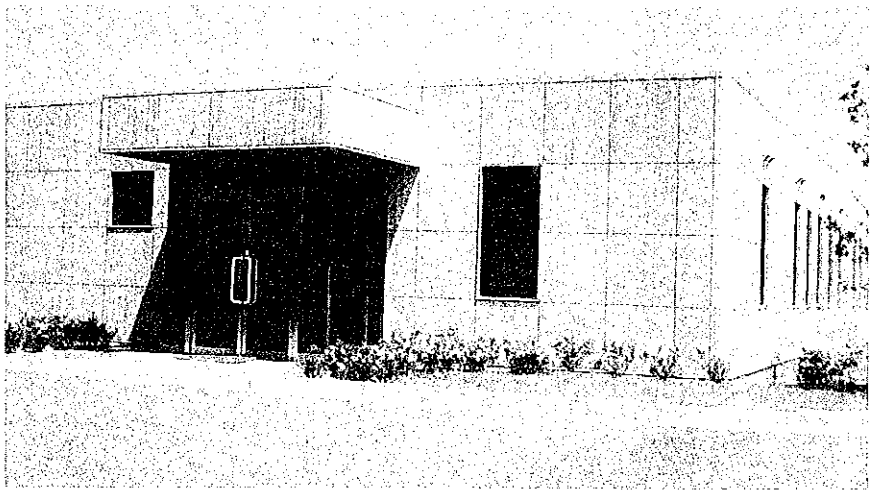


Lattice reinforcement of continuous carbon fibers bonded together with resin was used in the wall footings and floor slabs at Showa Base in Antarctica. The wall footing reinforcement was cut to fit the irregular shape of the rock surface on which the building was constructed.

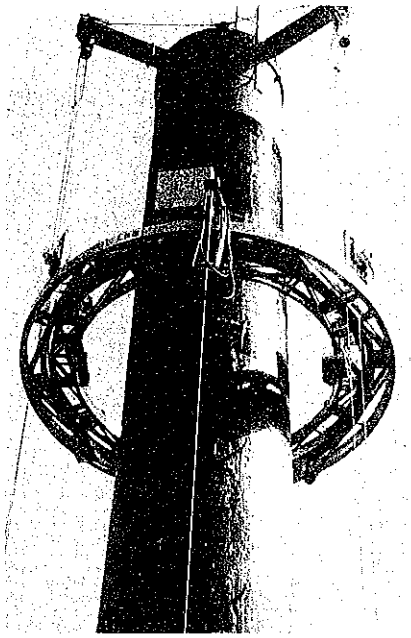
the finish materials with a fiber mesh fixed to the substrate by means such as anchor pins and fixing the mesh to the finish materials using resin mortar.

Selected for reader interest by the editors.

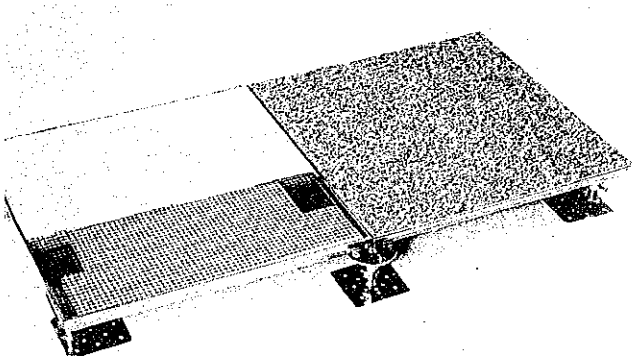
Takayuki Hirai is a professor in the Faculty of Engineering, Oita University, Japan. He is specializing in the development of cement matrix composite materials and FEM and BEM computer analysis of the mechanical behavior of composite materials.



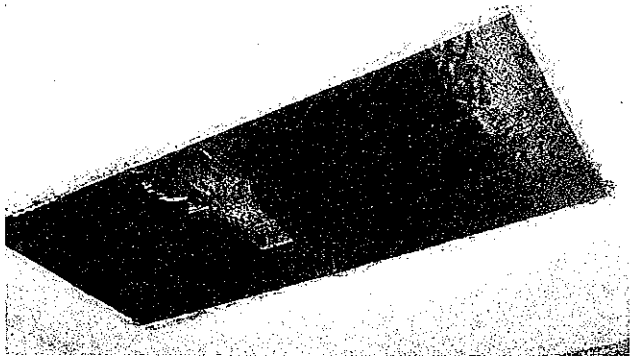
The exterior wall panels of the Taisei Biotechnology Research Center in Chiba Prefecture were made by laminating prepreg sheets of cement-filled continuous carbon fiber bundles.



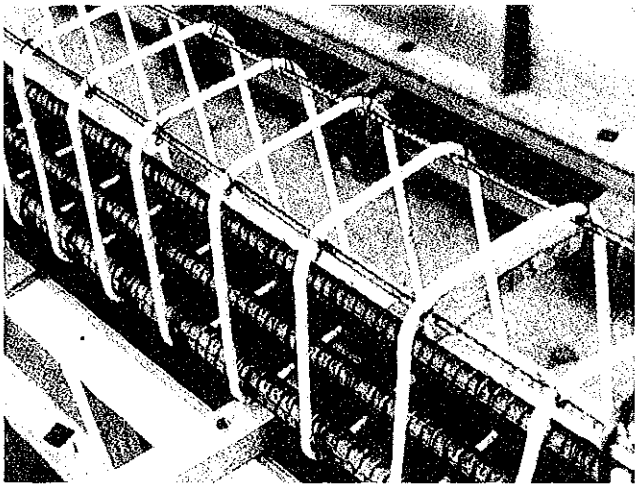
Uni-directional carbon fiber prepreg was resin-bonded to this chimney with the fibers aligned vertically to improve flexural strength, and carbon fiber strands were wound circumferentially to prevent cracking due to thermal stresses.



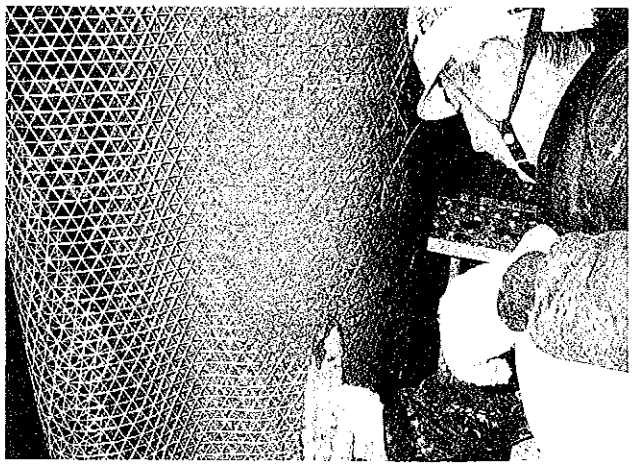
A free access floor panel of concrete reinforced with a mesh of continuous carbon fibers bonded togeter epoxy resin.



A uni-directional prepreg of carbon fiber bonded with resin to the underside of this reinforced concrete slab to improve flexural strength and reduce deflection due to cracking.



Accordion-type stirrups with no splices.



A triaxial screen being used to reinforce finish mortar on a column.