



Panel molds are filled to about 50% capacity. The foam concrete then expands over four hours to fill the molds to capacity.

Concrete homes can be built in a variety of ways, including stay-in-place foam forms, concrete block, insulated precast sandwich panels, tilt-up concrete panels, and shotcrete applied over wire mesh and a foam core. In Florida, a precast producer has introduced a residential concrete building system that utilizes fiber-reinforced, lightweight, cellular concrete panels. The panels can be used for both interior and exterior walls and for the roof.

The panels are made using a slurry of Type I portland cement, polypropylene fibers (1% by volume), and a proprietary foaming agent. The mix ingredients are combined in a high-speed mixer and panel molds are filled to about 50% capacity. The foam then expands over four hours to fill the mold to capacity. After the foam has expanded, the forms are stripped and the panels are cured by covering them with plastic and injecting steam underneath the plastic for one hour.

The panels are manufactured by Thermoflex Inc., Miami. To date, three homes have been built using the panels. Two homes have been constructed in Venezuela and one was built by Habitat for Humanity in the Miami area. The homes in Venezuela used the panels for exterior and interior walls and for the roof. The Florida home used the panels only for exterior walls.

The building system seems to have gained acceptance in Venezuela. According to Eugene Berger, Thermoflex technical engineer, "The factory in

Venezuela recently received a contract for the construction of 32 additional homes that will use the panels for the exterior, interior, and roof."

The main advantages of the panels, according to Berger, are thermal efficiency, light weight, impenetrability, fire resistance, and the strength to withstand hurricane-force winds.

Thermal efficiency. Tests according to ASTM C 236 for surfaced skim-coat plastered panels resulted in an R value of about 16.

Impenetrability. The panels were subjected to a large missile impact test that consisted of using a compressed-air pipe cannon to shoot a 9-pound piece of 2x4 lumber into the test subject. The panels were tested by shooting the 2x4 into the panel at a velocity of 55 mph. Inspection revealed penetrations about 3/8 inch deep. Hairline surface cracks on the side of the panel opposite the impact site also were found. No other evidence of damage was noted.

In addition, the panels were tested for their ability to stop steel-jacketed bullets fired from firearms of a variety of calibers. In all of the tests, the panels stopped the projectiles with little or no damage observed on the opposite side of the panel.

Fire resistance. Fire testing, according to ASTM 136, was done at 1,382° F to determine smoking, flaming, and weight loss after exposure. Weight loss was less than 26% with no flame or smoke observed. Surface burning characteristics, done in accordance

Fiber-reinforced cellular concrete homes

with ASTM E 84, resulted in flame spread and smoke development indexes of zero.

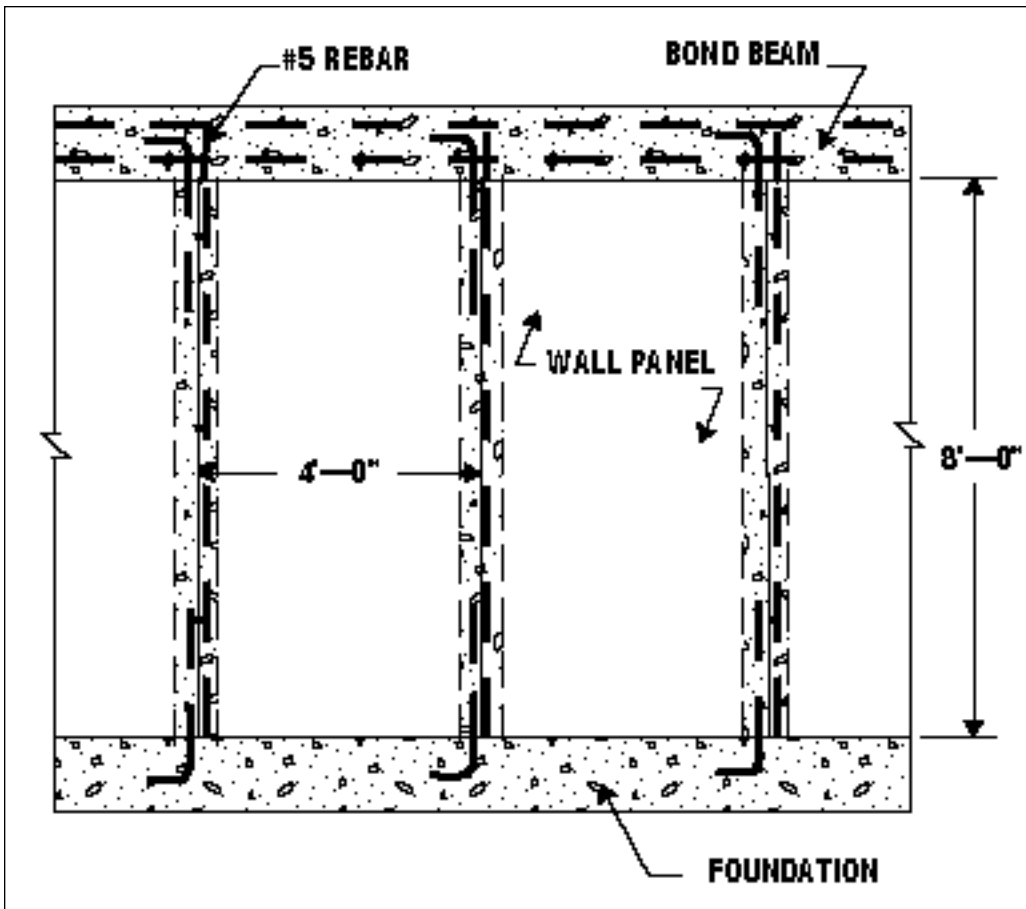
Strength. Tests of the panels in a typical application subjected them to equivalent wind loads exceeding 300 mph. At equivalent winds in excess of 198 mph, some cracking was heard. However, an inspection conducted after exposure to an equivalent wind load of 328 mph revealed only minor cracking in the normal-weight concrete columns and fiber-reinforced concrete panels.

Although panel costs are slightly higher than conventional masonry, savings are realized in field labor costs, which offset the higher material costs. These savings do not take into account insulating costs.

"The standard size for panels in the United States is 4 feet wide and up to 16 feet long," Berger says. "For all of the existing homes, we have simply cut

PROPERTIES OF FIBER-REINFORCED CONCRETE PANELS

Density.....	35 pcf
Compressive strength.....	800 psi
Tensile strength.....	740 psi
Thermal expansion coefficient	6.2E-6/°F
Surface burning characteristics	
Flame spread	0
Smoke developed.....	0
Water absorption ...	58.6% by weight
Permeability.....	0
Thermal value.....	R16
Acoustic insulation (between 100 and 4,000 Hz).....	41.4 db



door and window openings in the panels wherever desired. In the near future, however, special panel sizes will be available." The panels are 7½ inches thick. Panel thickness, however, can vary from 4 to 12 inches.

A typical 4x8-foot panel has a density of 35 to 40 pcf and weighs about 680 pounds. The relatively low weight of the 4x8-foot panels allows them to be transported easily to the jobsite and, once there, to be lifted and set into place using truck-mounted cranes.

During assembly, the panels are butted against one another. A 3½x3½-

inch groove along the edge of each panel forms a 3½x7-inch cavity centered on #5 rebar dowels anchored into the foundation footing and extending into the cavity. A single length of #5 reinforcing bar is then placed into the cavity and grouted into position. To comply with the South Florida Building Code, the 4x4-inch columns are tied into a concrete bond beam on top of the panels. The bond beam contains two continuous #5 rebar. The code requirement helps ensure vertical continuity and shear wall action to transfer lateral and vertical uplift forces. 