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Building Materials: Cementing the Future

By PETER GUMBEL / LYONS

French architect Jacques Ferrier is a big fan of concrete. He has used it extensively in his latest work, including the French pavilion he has designed for the 2010 World Fair in Shanghai, and believes it has strong aesthetic appeal. "It has a sensuality," he enthuses. "It evokes images of white minerality." Most of all, Ferrier praises concrete for its environmental properties. One of his concept projects is Hypergreen, a showcase tower with a curved concrete lattice façade, designed to generate enough energy to meet most of its own needs.

Yes, concrete. Not the cheap, gray, easily cracked, soulless stuff that gave urbanization a bad name when it was slathered over Western cities in the 1960s, but newfangled, bright — and still relatively expensive — concrete that has come onto the market this decade. High-performance or ultra-high-performance concrete, as it's known in the industry, is up to 10 times stronger than regular concrete. Although, pound-by-pound, it costs several times as much as regular concrete, industry officials say price comparisons are misleading because the high-tech versions have different properties that make them more comparable to materials such as stainless steel or aluminum — which are often more expensive still. The latest concretes have other advantages, including setting much faster. That's giving architects, engineers and builders far greater flexibility to use the material's long-lasting, thermal and acoustic properties in everything from pedestrian bridges to bus stations — and, in turn, contributing to big energy and other environmental savings. Some of the innovations are startling: the white concrete used by American architect Richard Meier for the Jubilee Church in Rome contains titanium dioxide, which keeps the concrete clean at the same time as destroying ambient pollutants such as car exhaust.

High-tech concrete is just one of the products that has emerged from the research and development labs of cement, steel and chemicals firms this decade, and it signals a growing commitment by heavy industry to the notion of "sustainability." As public pressure has grown to reduce energy use and carbon emissions — and in general tread more lightly on the environment — companies in these industries have poured money into R&D efforts. Much of the work has focused on internal processes, especially on the critical task of finding out how to cut down on emissions during manufacturing. But in their labs, scientists have also been playing with the materials themselves, swapping around molecules and gazing at atomic structures through electron microscopes in the hunt for new, "greener"

variations. The idea is to improve the entire life cycle of the product — not just how it's made, but also how it's used. A heightened sense of social responsibility isn't the only motive; as firms are quickly finding, innovations that are good for the environment can also give them a competitive advantage.

Cleaning Industry

At the research and development labs of steel giant ArcelorMittal in Belgium, researchers are trying to develop thinner, stronger steel that can replace plastic in washing machines and other appliances. They're also experimenting with coatings that are both environmentally friendly and more effective in fighting corrosion. Dulux Trade, the paint subsidiary of Netherlands-based chemical firm AkzoNobel, this year started selling Ecosure, a type of paint with much reduced amounts of embodied carbon and other volatile organic compounds. And at the R&D center of French cement firm Lafarge, director Pascal Casanova waxes lyrical about Ductal, a super-resilient product the center has developed that he calls the "Formula One" of concrete. It's what architect Ferrier intends to use in his 807-ft. (246 m) Hypergreen tower, a project that could not be built with regular concrete.

Of course, the beneficial environmental effects of such new products are still dwarfed by the sheer volume of emissions that heavy industry spews out. Yet the time and money being spent on cutting-edge research shows that many companies are paying far more than just lip service to the notion of cleaning up their act. "Heavy industry in general faces some of the biggest problems because of what it does, but it was also the first sector to recognize that it had a problem," says Peter Madden of the London-based ngo Forum for the Future, which worked together with Dulux on the Ecosure product.

As the world economy falls on hard times, one of the big questions is whether these research efforts may be cut or curtailed. Björn Stigson is president of the World Business Council for Sustainable Development, an organization of about 200 companies committed to smart environmental policies. Some cutbacks are inevitable, he believes, but "sustainable development is now an integrated part of doing business. It's not a question of environment versus business. It's a business issue, and if companies don't address it, they will have problems with their license to operate and grow." His business council has been working with most of the leading players in the cement, metals and mining, and electric-utility industries to define specific targets for such things as CO₂ emissions and responsible use of fuels and materials that the firms then commit to meet.

To get a sense of how technological progress is translating into environmental gains, take a trip to Lafarge's research campus, just outside the French city of Lyons. The world's largest cement company, Lafarge has set itself a goal: by 2010, it will cut its net CO₂

emissions for every ton of cement it produces to 20% below the 1990 level. But it is also steaming ahead with research into smarter, stronger and less polluting products, including ultra-high-performance concrete. Research director Casanova traces the path of innovation back to the 1980s, when the first big gains were made in increasing the resistance, or strength, of concrete. In the two decades since, researchers have figured out how to increase that resistance by a factor of 10. "There has been a very important revolution over the past 20 years, and it's not over," Casanova says.

Stronger concrete translates into significant gains for the environment because it can be used more thinly, consuming considerably fewer raw materials than regular concrete. Moreover, concrete has some properties that make it intrinsically energy-efficient when used in buildings. It insulates well because it doesn't let in wind and water. Its density also means it stores heat during the day and releases it at night, enabling savings on air conditioning and heating; architects including Ferrier are playing with such possibilities as they design their new buildings. And the ultra-high-performance concretes can be put to surprising uses: in a showroom on the Lafarge campus is a concrete table so thin and elegant that from a distance you might think it was made of marble.

Lafarge is by no means alone in focusing on innovation. Franz-Josef Ulm, a professor of civil and environmental engineering at the Massachusetts Institute of Technology, says "there's not one single cement company that isn't looking at ways to improve the resistance of concrete." The next step, he says, "is to achieve materials with higher strength, but which use the same amount of initial material."

Back in Paris, architect Ferrier acknowledges that some clients are skeptical when he proposes concrete. But "the environmental advantage is clear: zero maintenance, zero painting and a very long life," he says. As soon as the price drops, he says, "we'll be able to explore more."

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