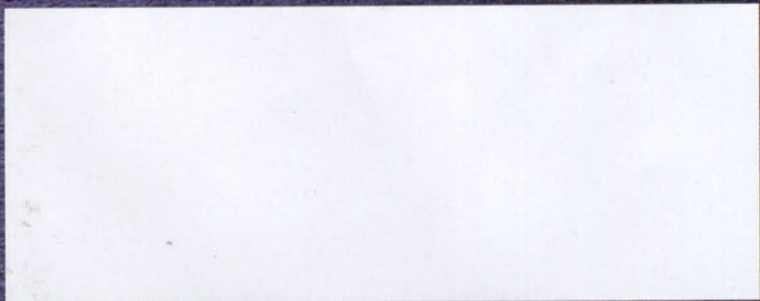
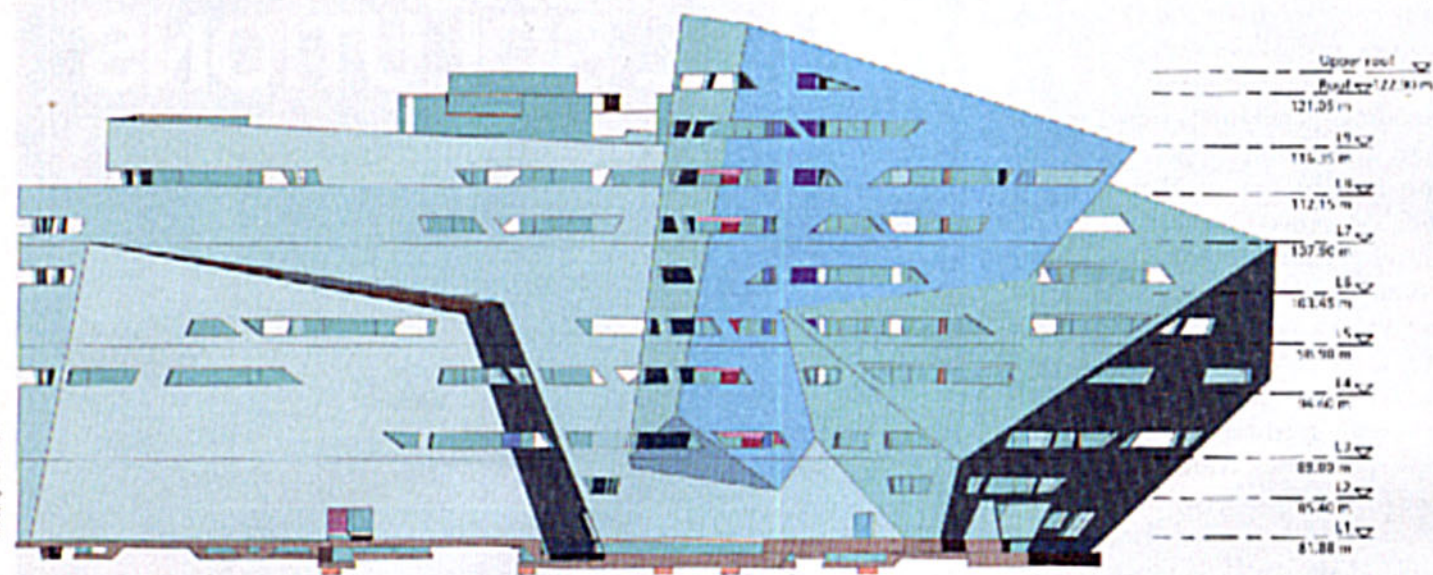


# Civil Engineering

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The nine-story, 24,600 m<sup>2</sup> reinforced-concrete Creative Media Centre will feature sloping external and internal walls—inclined at angles up to approximately 60 degrees from the vertical—that will create different internal floor layouts at each level.

challenge of local planning restrictions that limited building heights to approximately 132 m above the average low tide in Hong Kong. Because the design team convinced local planners that the highest points

of the crystalline structure should be considered architectural forms rather than occupied building space, the team obtained an exemption that will permit these points to extend approximately 3 or 4 m above the

height limit, notes Delaney. The building is expected to be completed by 2010 at a cost of approximately 500 million Hong Kong dollars (U.S.\$64 million).

—Robert L. Reid

## STRUCTURES

### Curtains of Water Form Expo Pavilion Walls

Engineers and architects alike have long appreciated the evocative power of water. Pools, fountains, and waterfalls, for example, have always been important elements of building design. But perhaps nothing in architectural history can properly prepare visitors for what they will encounter this summer at an international exposition in Zaragoza, Spain: a building that is actually made of water.

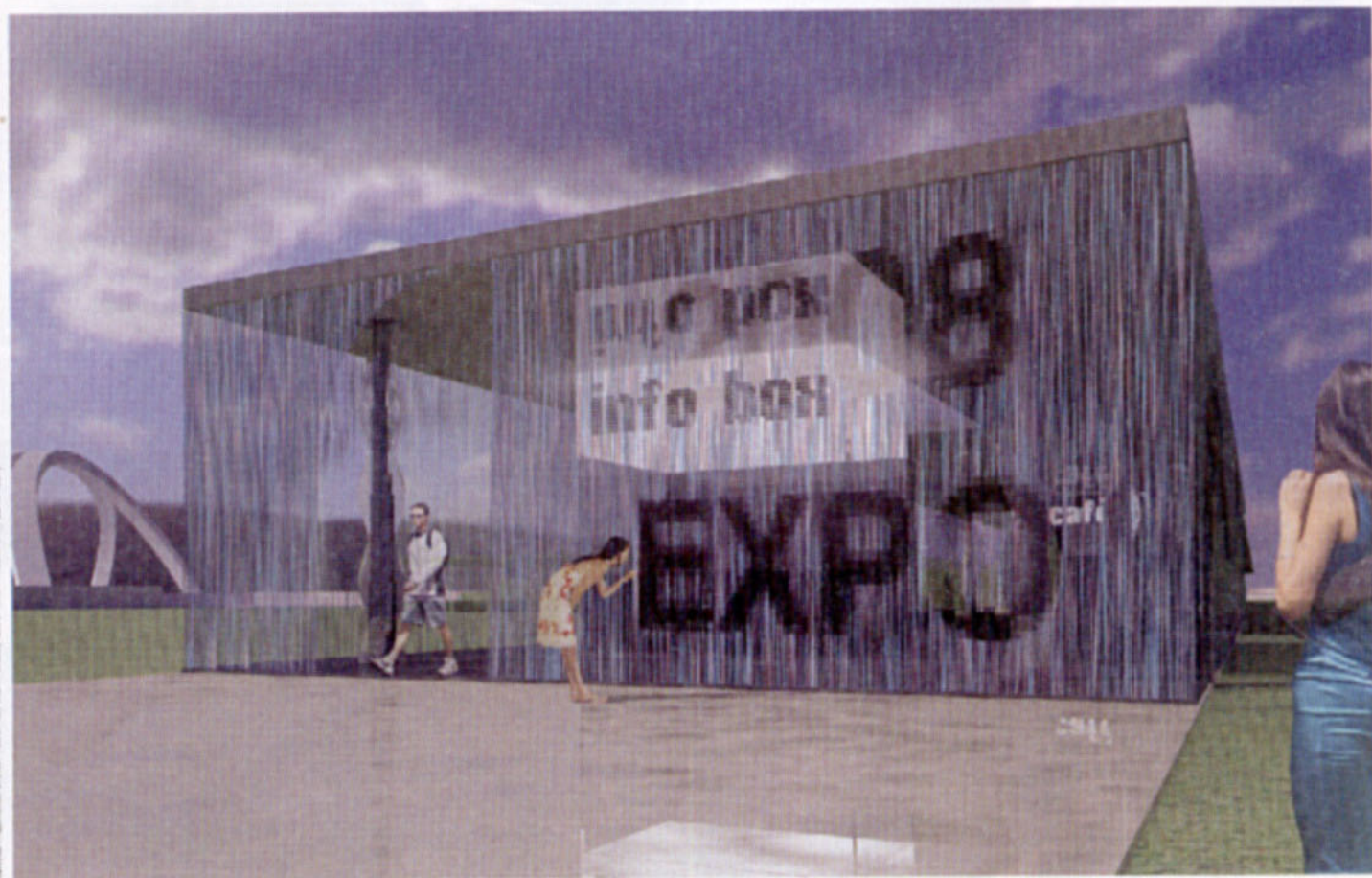
Located near the entrance to Expo Zaragoza 2008, the Digital Water Pavilion will welcome visitors. But its designers wanted to create a structure that would do more than simply house exhibits, explains Matteo Lai, the team leader for the project architect, carlorattiasociati, the principals of which are Walter Nicolino and Carlo Ratti.

The firm has offices in Cambridge, Massachusetts, and Turin, Italy. The designers envisioned a building that would itself convey information—not on fixed signs or video screens but in words and images formed by drops of falling water.

The 400 m<sup>2</sup> pavilion will have a basement, a ground-floor slab of reinforced concrete, and a steel roof. Inside the structure will be two enclosures, one 11.5 by 5 m and the other 3.5 by 8.5 m, constructed of steel and glass. But the perimeter walls and other interior partitions will consist only of thin curtains of falling water. Instead of simply cascading from the roof like a waterfall, however, the flow of water will be carefully controlled by a line of valves that release it drop by drop.

The falling drops of water will form words and images in the air in much the same way that an ink-jet printer forms them on a page, explains Ratti, who also heads the Massachusetts Institute of Technology's sensible City Laboratory. Each valve can either open to release a drop of water or close to create a gap between the drops. As the valves rapidly open and close according to a computer-controlled sequence, the drops of water will fall to the ground in prearranged patterns. In effect, each drop will become a pixel on a continuously scrolling display.

In addition to conveying information, the water walls will make the building easily reconfigurable, says Lai. Portions of the walls may be opened or closed temporarily at any time to meet



The Digital Water Pavilion, which will be located near the entrance to Expo Zaragoza 2008, will feature walls consisting of thin sheets of water that will fall in carefully controlled patterns to spell out messages to attendees.

the needs of the building's users. It will even be possible for people to interact with the walls in unusual ways. For example, sensors can be installed that will detect an approaching visitor and trigger the opening of a "door" at just the right time.

When the building is not in use, it can virtually disappear thanks to the 12 hydraulic pistons that support its 40 by 10 m steel roof. The pistons can raise the roof to its full height of approximately 4 m or lower it to the ground, notes Carlos Merino Agüeros, an associate in the Madrid office of Arup, which is performing the structural and mechanical engineering for the project. Wind loads on the roof will be transferred to the pistons, which have the capacity to absorb lateral loads while also accounting for

buckling. In especially windy conditions, the roof will be lowered, and the footprint of the building will become a public fountain.

Environmental sustainability is a major goal of the project. Water that has fallen to the ground will be collected via a porous floor material and will then be filtered, cleaned, and returned to the roof for reuse in the water walls, says Lai. Furthermore, although some of the water will inevitably be lost to evaporation, the cooling effect will eliminate the need for air-conditioning.

The concept of the Digital Water Pavilion arose from a desire to create an iconic structure for the city of Zaragoza both during and after the exposition, says Lai. The theme of the exposition is water, and the pavilion is located in the midst of a major urban

renovation project that is expected to showcase the theme of digital technology. Participants in a class at the Massachusetts Institute of Technology who were developing urban design ideas for Zaragoza proposed combining the two themes in a wall of "digital water." Arup, carlorattiassociati, and the Paris-based landscape architecture firm Agence Ter then applied that concept to the pavilion design.

The building, which is expected to cost approximately €3 million (U.S.\$4.4 million), is scheduled for completion in May, just in time for the June opening of the exposition. After the expo has ended, the area surrounding the building will be converted into a park, and the pavilion itself will house a café.

—Jeff L. Brown