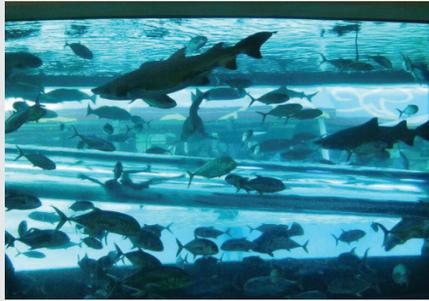


ACRYLIC IN MODERN AQUARIUM CONSTRUCTION

Aquarium Window Design Types and Examples



by **Reynolds**
POLYMER TECHNOLOGY, INC.
Way Beyond Ordinary.



The shark slide at the Golden Nugget resort in Las Vegas, Nevada.

"Modern technology and materials have provided for attraction exhibits that were simply not possible a relatively short while ago."

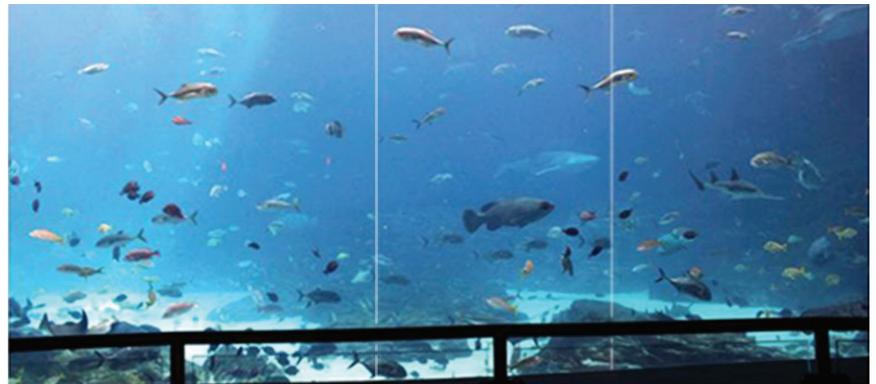
Overview

Modern technology and materials have provided for attraction exhibits that were simply not possible a relatively short while ago. For example, could past generations have imagined a place where they could stand, at room temperature, while observing polar bears swimming by overhead? Or sliding safely through a clear tube within shark-infested waters? Most likely not, but such surrealistic experiences are available in many locations today through the use of acrylic. Modern aquarium and zoo windows are almost exclusively being made from this material that can be made to nearly any shape or size, is lighter than glass, stronger than concrete, and completely transparent.

Flat Panels: Cube Oceanarium • Chengdu, China

The most common type of aquarium exhibit is based on the flat acrylic panel. Such windows may be rectangular or circular, small or large. What all quality flat panels have in common is the ability to safely retain water and a remarkable clarity. The thickness and shape of the panel will be the result of many factors, including the size of the exhibit and the type of animals within.

Today's aquarium visitor has grown to expect panels of a certain size. So called "mega panels" can be anywhere from the length of a small semi-trailer to that of a commercial airliner. All such windows are made possible though chemical bonding, which allows multiple panels to be fused together. However, with many acrylic manufacturers, there are all too often unsightly bonds that ruin the illusion being sought by the public, which is the momentary sense that they are somehow



Unsightly bonds, as shown here on a competitor's panel, inhibit the viewing experience of guests.

immersed inside of an underwater world versus standing outside of one. Not until recently has there been a way to truly erase bonds from the public eye.



The recently opened Cube Oceanarium in Chengdu, China is one of the largest aquariums in the world. Here we find a variety of flat acrylic panels being utilized to provide the public with extraordinary underwater views. Cube has an incredible 10,000 different species of marine life including both warm and cold water exhibits.

Two panels at Cube Oceanarium designed by acrylic manufacturer Reynolds Polymer Technology belong to a new breed of viewing window that feature the nearly invisible Signature Bond. Each panel is 24-feet high, 17-feet long and tilted at a 10 degree angle. The windows weigh in at 24 tons a piece and are 15" thick. Each required a 24-foot vertical bond to fuse two separate panel sections together. Neither bond is detectable from the majority of viewing angles. How is this possible? Proprietary RPT technology has allowed even the longest of bonds to be positioned and scaled like no other bond on the market.

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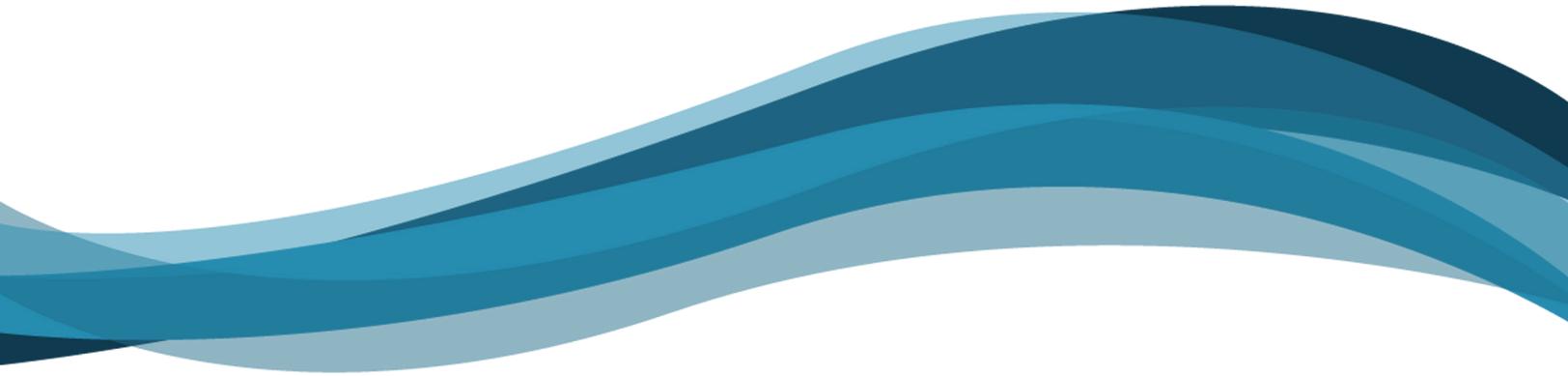


A Signature Bond panel at Cube Aquarium. A 24 ft vertical bond runs down the center.

What Cube Oceanarium represents is nothing less than the future of bonded acrylic aquarium panels. Coming soon are R-Cast® viewing windows of a larger size than ever seen before and without detectable chemical bonds. Look for aquarium attendance numbers to grow as public opportunities to become one with the undersea world become more and more spectacular. The virtual or V-Quarium will also play a larger role moving forward. Projection flat panels, such as those featured at the City of Dreams in Macau, China, allow for the illusion of any variety of plant or animal life that one can bring to mind, including mermaids as pictured at left.



The V-aquarium at the City of Dreams features an elegant "underwater" mermaid show.



Tunnels: Journey to Churchill • Winnipeg, Canada

The principle advantage of an underwater tunnel is that it allows the audience a view of what's going on in the waters above them, not just in front. The sight of the underbelly of a shark swimming overhead is certain to bring out delight in any crowd. However, another advantage of aquarium tunnels is their ability to direct traffic. Tunnels encourage movement. Those walking in will naturally meander to an exit on the other side, allowing guests to be ushered through without feeling rushed. Nothing can clog an exhibit or walkway like a handful of guests milling around without progressing to the next station. On especially busy days, of which there are hopefully many, the aquarium tunnel can be friend to both the public and staff.

Journey to Churchill in Winnipeg, Canada represents an expertly designed example

"Six-inch thick tunnel walls are used to separate man and bear, though the clarity of R-Cast® greatly reduces the perceived thickness."



Guests hope to spot a polar bear through an R-Cast® tunnel at Journey to Churchill.

of the modern aquarium. There are a handful of underwater acrylic tunnels at the park that allow for submerged viewing of a variety of wildlife. Churchill is home to both polar bears and seals—a combination that normally would not mix well at all, but appears to thanks to a nearly invisible barrier of clear acrylic between tunnel exhibits.

Visitors can observe the earth's largest bear species while safely inside an R-Cast® aquarium tunnel that is over 35-feet long, 8-feet tall and 10-feet wide. Six-inch thick acrylic tunnel walls are used to separate man and bear, though the clarity of R-Cast® greatly reduces the perceived thickness. This structure is especially unique in that it has



One of the many benefits of tunnels is their ability to direct the flow of traffic.

"The dome room provides a transparent area with ample walking space and 360° views of the surrounding environment."



The seamless dome room at Oklahoma Aquarium .

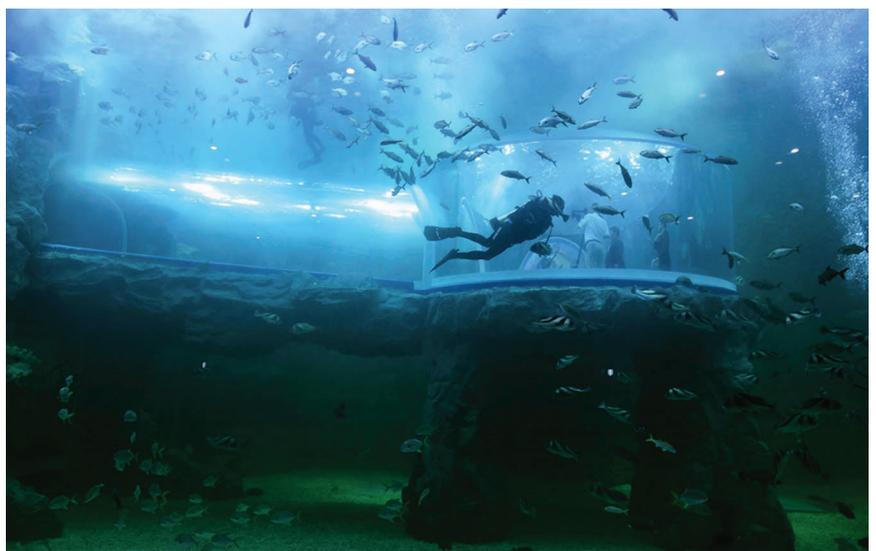
a 21 foot wide, 13 foot tall transparent face that allows for additional views.

The second R-Cast® tunnel at Journey to Churchill is slightly smaller in length at 19 feet. However, this tunnel lets visitors observe not only bears but ringed seals as well. A nearly invisible divider gives the appearance that both animal groups share the water in harmony. The seal exhibit's main observation window is 16 feet wide and allows for 11 vertical feet of viewing. A series of concave demi-tunnels provide further insight into the seal exhibit.

The acrylic tunnels at Churchill, in combination with a variety of large flat panels, offer some of the finest up-close opportunities for wildlife viewing in all of Canada. Over 100,000 people visited the park within its first month of opening, a testimony to the drawing power that such exhibits can possess.

Dome Rooms: aqua planet Yeosu • Yeosu, South Korea

A type of structure that has gained considerable popularity in recent years is the acrylic dome room. The dome room provides a transparent area with ample walking space and 360° views of the surrounding environment. Their spherical shape provides for more panoramic viewing opportunities than does the traditional flat aquarium panel or tunnel. When positioned in a larger exhibit with ample aquatic life, there is perhaps no better way for guests to witness the splendor of the sea than inside a dome.



A lone diver swims beside the large dome at aqua planet Yeosu. Note the crowd inside the dome.



Dome rooms are rising in popularity for many reasons, not the least of which are the aesthetic advantages. Their saucer-like shape and curved lines give a sleek appearance. Domes bring with them, especially in combination with a tunneled entrance, a sense of exclusivity. When outfitted with accents such as flooring and seating options, dome rooms perhaps resemble a private submersible vehicle giving a VIP tour of the ocean depths.

"Yeosu's acrylic dome room is arguably the most photographed element of the park."



An internal view of the dome at Yeosu, which provides ample views in all directions.

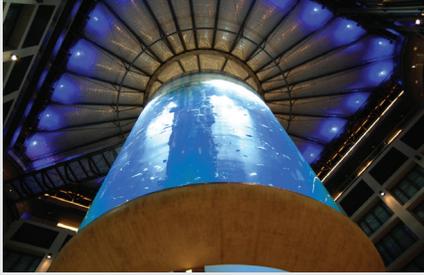
The dome room at Yeosu, at one time the largest in the world, has a diameter of 20 feet and is entered via an underwater tunnel on either side. This dome, the first of its kind in Asia, was designed to impress guests, immersing them and allowing them to see aquatic life not just in front of them, but above them and all around them. Situated on top of a designed rock formation, the dome at Yeosu is without mullions or unsightly bonds. Crystal clear R-Cast® walls are strong enough to keep the integrity of the structure, yet not so thick as to distort the view.

Yeosu's acrylic dome room is arguably the most photographed element of the park. It serves as a backdrop for aquatic shows and gives visitors a sense of scale. Additionally it aids in providing a unique set of reciprocal views. Those looking through the main viewing panel, which is an impressive 56-feet long by 23-feet high, can see those in the dome and vice versa.

RPT has manufactured dome rooms similar to that at Yeosu at Indian Springs Metro Park, Indianapolis Zoo, and Oklahoma Aquarium to name a few. Aquarium builder



Mullions, as seen here at Indianapolis Zoo, are an affordable alternative to chemical bonds.



The AquaDom at the Radisson Blu Hotel in Berlin, Germany.

"The concept of the cylinder-shaped aquarium, first made popular at the AquaDom in Berlin, has truly proven to capture the imagination of the sight-seeing public."

Reynolds Polymer is able to offer value aquarium engineering options as well to help ensure that such a structure will fit within budget. A reduction in wall height, diameter, or the substitution of mullions for chemical bonds can all serve to reduce the price.

Cylinders: Avia Park Mall

The concept of the cylinder-shaped aquarium, first made popular at the AquaDom in Berlin, has truly proven to capture the imagination of the sight-seeing public. The exposed nature of such aquarium windows puts the entire tank on display. Visitors are able to see every fish and plant from multiple angles. In many other types of tanks, views inside are limited to only a couple of panels, leaving the true size of the habitat underappreciated or assumed by the eye. Large acrylic cylinder tanks leave no room for doubt as to the impressive scale and engineering involved in custom aquariums.



The tallest cylindrical aquarium in the world at Avia Park Mall, Moscow.

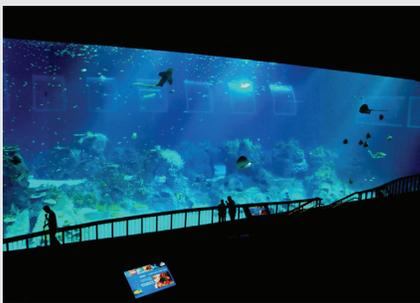
The aquarium at Avia Park Mall is the tallest cylindrical aquarium in the world. In fact, the divers who maintain the aquarium's interior must make compression stops. All told, the aquarium is 75-feet tall, 20-feet in diameter and holds 98,000 gallons of salt water. To contain such pressure, the walls were engineered to be up to eight inches thick, requiring a total of 55 metric tons of acrylic.

Visually, the aquarium at Avia Park has a hypnotic quality while being home to 2,500 specimens of fish and a majestic, spiraling Red Sea reef. Structurally, however, the attraction is more a model of precise aquarium engineering than aesthetic craft. What appears to be



Inside the underwater elevator at Morocco Mall, Casablanca.

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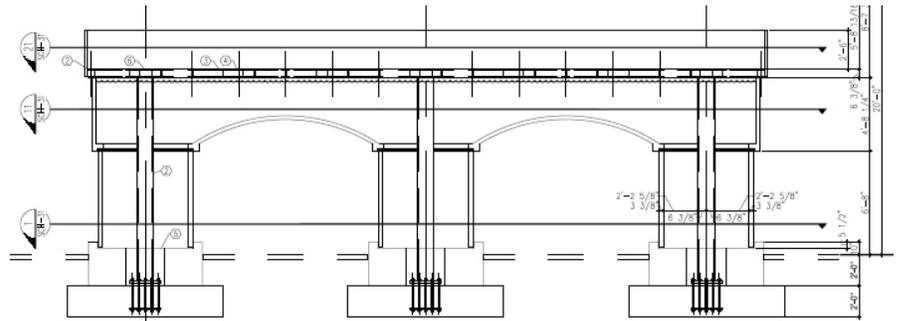


Mega panels, such as this one at Singapore's SEA Aquarium, are subjected to pressure from millions of gallons of water.

a single column actually consists of 21 separate panels of R-Cast® chemically bonded into seven sections that weigh as much as 13 tons each.

Two cylinder projects by Reynolds Polymer, AquaDream in Casablanca and AquaDom in Berlin, include stunning underwater elevators that run directly down their centers. No visitor will be soon to forget the thrill of descending into the depths while looking down on a crowded, modernistic mall. Providing such experiences is the reward of every individual player in the trade and a duty of the attractions industry itself.

Design



The complex and technical elements involved in aquarium design require an experienced firm.

When acrylic is used in an exhibit featuring water, animals, or (as often the case) both, nearly every facet of the panels must be carefully considered. The shape, length, height and thickness of each panel is determined in response to factors such as water load, animal load, and environment.

Custom acrylic panels in zoo and aquarium applications can be subjected to pressure from thousands (or even millions) of gallons of water, wind, and a variety of environmental temperatures. Therefore, a safety factor that is many times beyond the minimum is necessary. All R-Cast® acrylic sheets are designed to a membrane tensile stress level of 800 psi. This acrylic design parameter gives a safety factor of 11.2 based on the ASME standard of 9,000 psi tensile strength. This essentially means that the panels are eleven times stronger than they need to be to handle a long term load, such as water.

In some cases, an animal such as a bear or seal can present a short term load for the panel. This also must be taken into account, including the weight of the animal and speed at which it swims. Yet another consideration is any damage that the animal may inflict on the viewing panel, such as ramming or scratching.

At the end of the day, designing and manufacturing the correct panel for a commercial aquarium, especially those that involve large amounts of water and/or wildlife, requires a highly competent aquarium manufacturer with considerable experience.