



# XR Geomembranes Case History: Singapore Landfill

The incinerated waste of Singapore will be deposited in a new offshore landfill lined with XR-5 geomembrane made with Dacron and Elvaloy

American humorist Will Rogers used to say, "Buy land; they're not making any more." In a nutshell, that's the problem the nation of Singapore spent \$1.6 billion to solve.

When Sir Stamford Raffles claimed Singapore for the British East India company in 1819, it was nothing but a swampy, thickly jungled island populated by a handful of fishermen and sea gypsies. By 1911, the population of Singapore had swelled to 250,000 people of numerous races, mainly from China's southern provinces, Indonesia, Malaya (now known as Malaysia) and India, speaking a total of 54 languages.

Singapore became a British Crown Colony in 1945. But the impetus for independence led to self-government in 1959 as part of the Malayan Federation, and finally an independent republic in 1965.

Today, this tiny tropical nation of 225 square miles at the southern tip of the Malay Peninsula is home to nearly 3 million people. Flourishing Singapore now is the world's busiest port and a major center of trade, banking, tourism and communications. Yet all of this prosperity and growth ran headlong into the nation's immutable geography - it continued to be a low-lying island fringed with mangrove swamps.

But prosperity breeds big ideas, and there was none bigger than Singapore's solution to a problem encountered by nearly every city, rich or poor. The problem: trash - what to do with mountains of trash.

The solution: annex 865 acres of seabed for a new offshore waste landfill, making it the largest reclamation project specifically for solid waste disposal in the world.

Engineered to replace the present landfill - which was full by 1998 - the massive \$1.6 billion project called for building of a 4.5-mile, environmentally secure embankment to encircle two nearby islands. The trapped seawater eventually would be replaced by some 80 million cubic yards of municipal waste consisting of 85 percent incineration ash and the balance in non-burnables.

By the time it's completion in 1999, more than 5 million tons of rock and 40 million tons of sand was barged to the construction site from Indonesia. Those mountains of material formed the embankment that is 25 feet wide at the top with a graded slope of one foot of height to each six feet of width.

With environmental safety a primary concern, the inside of the embankment was lined with more than 4.5 million square feet of XR-5, a geomembrane designed to withstand both the long-term effects of the tropical environment and the rigors of the installation process.

The geomembrane was manufactured by the Seaman Corporation in prefabricated panels as large as 20,277 square feet. Once they arrived on the jobsite, divers dragged the panels over the base of rock and sand, then anchored atop the berm. There's an overlay of two meters between the adjoining panels. A layer of sand is spread over the geomembrane layer to hold it in place.

"By the time the XR-5 had been exposed to the high heat and humidity of Singapore, dragged over the base of rock and sand, walked on by construction crews and driven on by heavy equipment, it had been exposed to an environment that would destroy other liners," said Jim Krakowski, assistant to the president at Seaman.

"Because XR-5 is designed for high abrasion, puncture and tear resistance, it was the ideal liner fabric for this application. XR-5 geomembrane has been used around the world for more than 20 years in containment liner and related applications, so we knew it was up to the challenge."

XR-5 is made incorporating DuPont Dacron polyester fiber and Elvaloy KEE resin. "The properties of the two products enabled us to develop a geomembrane superior to anything else on the market," said Krakowski. "XR-5 is absolutely outstanding with it comes to standing up to tears and punctures, and it has great UV and chemical resistance."

Seaman does its own weaving of the Dacron fiber, varying the tightness of the weave according to the application. Explains Krakowski: "The XR-5 used in the Singapore project was a tightly knitted base fabric using Dacron, a key to the high puncture resistance of XR-5. It then receives a PVC coating containing Elvaloy KEE, which imparts permanent flexibility to the PVC. We end up with a homogenous material, so the coating doesn't peel off the yarn. This is what gives XR-5 such good abrasion resistance, which is critical during installation."

Concludes Krakowski: "We have a long history of working in partnership with DuPont to develop products that have helped us gain a foothold in new markets. The Singapore project is a good example of what we can accomplish together and how we might take advantage of opportunities in the future."

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