



Loving and Loathing Japan's Concrete Coasts, Where Tetrapods Reign

Stephen Hesse

Ah, tetrapods!

Standing strong year after year, from sunrise to sunrise, silent sentinels unmoved by summer's raging typhoons and winter's crashing ice floes.

Not sure what to think of tetrapods? Not even sure what they are? Well, fear not, you're probably in the majority.

But what you don't know may surprise you.

Among those who do know and care, tetrapods inspire passionate and widely divergent opinions.

Here are a few of the words and phrases that have been used to describe these evocative creations: Massive and practical, cute and pretty, irritating and ordinary, queer, sexy, destructive, perverse, sophisticated, a blight on Japan's beauty.

If you live in Japan and have ever visited the coast, then you've probably seen tetrapods, perhaps dozens of them, even if you didn't realize what there were. From Hokkaido to Okinawa, just about anywhere you find a road, a railway, or buildings close by the coast, it's likely you'll also see rows of these large concrete objects piled at the base of cliffs, along the beach, or in the shallows just offshore.



Rooms with a view, Yokosuka, Kanagawa prefecture. Photo by Aoyama Ken

Before concrete became the darling of development in Japan, the only tetrapods you would have found while beachcombing were those of the animal variety. Taken from Greek, tetrapod means "four-legged," and thus the English meaning, a four-legged animal.

On beaches in Japan today, tetrapods of the concrete variety are as common as their animal namesakes and come in a surprising range of sizes. One Japanese company, Fudo Tetra Corporation, has a line of 18 different blocks that range in size from half a ton (90cm in height and one meter in width) to 80 tons (5 meters tall and 6 meters wide).

TETRAPOD is a registered trademark held by Fudo Tetra, but it is also a term used to refer to any of the multi-legged concrete blocks that come in a variety of configurations, with from 3 to 8 legs.



Fudo Tetra's waterfront activities

Tetrapods were designed to remain stable under even the most extreme weather and ocean conditions and when arranged together in lines or piles, they create an interlocking, porous barrier that dissipates the power of waves and currents.



Tetrapods in action during a July typhoon that hit Kyushu. Photo by Aoyama Ken

Prior to World War II, this kind of coastal breakwater armoring was primarily accomplished using rocks and boulders, and sometimes concrete cubes. Then in 1950 the Laboratoire Dauphinois d'Hydraulique in Grenoble, France, now known as Sogreah, began making Tetrapods for coastal defense. The concept took off and engineering firms worldwide began creating their own variations on the same theme.

When we started doing research for this article we simply wanted to find out more about tetrapods and what people think of them. Little did we know that we would find tetrapod lovers, haters and an extended family of armoring units with evocative names that belie their humble purpose.

Eight years after the Tetrapod made its debut, Americans created something called the Tribar that looks like a huge concrete trivet. The die was cast.

These shapes were followed by the Modified Cube (US, 1959), the Stabit (UK, 1961), the Akmon and the Tripod (NL, 1962), the Cob (UK, 1969), the Dolos (RSA, 1963), the Antifer Cube (France, 1973), the Seabee (Australia 1978), the Shed (UK, 1982), the Accropode (France, 1980), the Haro (Belgium, 1984), the Hollow Cube (Germany, 1991), the Core-Loc and the A-Jack (USA, 1996 and 1998, respectively), the Diahitis (Ireland, 1998, and the Samoa Block (USA, 2002).

You get the idea: It's not just coastal armoring, it's a tradition.

In addition to these forms of "hard stabilization" there is also "soft stabilization," but we'll get to that later.

Japan has long been enamored of fortifying and excluding. Just as Japanese rulers toiled for centuries to build impermeable castles, so, too, the nation has sought to harden its coasts against waves and currents, loath to give an inch to the sea.



Tetrapods fresh from their molds at Yokosuka set to further denature Japan's coasts

Brittanica.com reports that Japan stretches a total of 2,900 kilometers from north to south, and comprises over 3,900 islands. But Japan's maximum land width is just 320 kilometers, so one can understand why every meter lost might be a meter lamented.

Nevertheless, recognizing how many people enjoy coasts that are rugged and wild or quiet and serene—and free from concrete, we assumed the consensus would be that tetrapods are an unwelcome intrusion upon nature. We weren't prepared to find individuals who profess great affection for these four-legged blocks.

One fan, 21-year-old Kobori Motohiro, an art student majoring in sculpture, tried to help us understand the appeal of tetrapods.



Tetrapod fan Kobori Motohiro

"It is difficult to explain why I got interested in tetrapods, because tetrapods don't benefit us directly in our daily life. They aren't pretty or delicious, nor do they give off a nice smell. However, one thing I'm sure of is that the practicality of tetrapods is not the reason why we are attracted to them," he said in an e-mail interview.

"Our love of the tetrapod has little to do with its practicality and I think this kind of phenomenon can be seen in areas of pure art, such as painting and carving. The common thing shared among people who love tetrapods and people who love art is that both groups of people love them no matter whether they are practical or not," he explained.

Kobori believes tetrapods are attractive because they DO NOT fit in with their natural surroundings. "I think the attraction of tetrapods lies in their contrast with nature. The material of a tetrapod is concrete and its shape is formal, which can't be found in nature. Also, it is manufactured by pouring concrete into molds. The tetrapod is a symbol of artificiality. Setting hundreds of tetrapods on a big scale that matches that of nature is simply art," he said.

The appeal of tetrapods led Kobori to make 60 mini-tetrapods for a university assignment and to his surprise many friends asked for one. "I didn't know so many people love tetrapods. Those friends are now using the mini-tetrapods as door-stoppers or as accessory-holders," he said.

"I heard that tetrapods are occasionally criticized because they destroy the scenery; however, I think this shows that people can't ignore the power of tetrapods as 'objects,'" he added.

Award-winning writer and Japanologist, Alex Kerr, is one of those who most certainly can't ignore tetrapods, but he doesn't see them as objets d'art. Kerr is author of *Dogs and Demons: Tales from the Dark Side of Japan* (Hill and Wang, 2001) and is a vehement critic of Japan's concrete culture.

"Today's earthworks use concrete in myriad inventive forms: slabs, steps, bars, bricks, tubes, spikes, blocks, square and cross-shaped buttresses, protruding nipples, lattices, hexagons, serpentine walls topped by iron fences, and wire nets," he laments in *Dogs and Demons*.

But it's not just concrete that Kerr abhors. It's the fact that concrete has become an institution in Japan. "TETRAPODS may be an unfamiliar word to readers who have not visited Japan and seen them lined up by the hundreds along bays and beaches. They look like oversized jacks with four concrete legs, some weighing as much as fifty tons. Tetrapods, which are supposed to retard beach erosion, are big business. So profitable are they to bureaucrats that three different ministries—of Transport, of Agriculture, Forestry and Fisheries, and of Construction—annually spend 500 billion yen each, sprinkling tetrapods along the coast, like three giants throwing jacks, with the shore as their playing board," he writes.



Tetrapods lining the coast at Yokosuka. Photo by Aoyama Ken

"These projects are mostly unnecessary or worse than unnecessary. It turns out that wave action on tetrapods wears the sand away faster and causes greater erosion than would be the case if the beaches had been left alone," he notes.

The Japanese Wikipedia site echoes some of Kerr's criticisms. "The unique shape and the color of wave-dissipating blocks are strongly criticized for ruining the Japanese traditional coastal scenery, which is associated with white sands and green pine trees," states the site.

But the website is more complimentary than critical. Japan needs the wave-dissipating blocks "to protect the coast from erosion, to protect our land from typhoons, and to sustain people's safety," it claims.

Wikipedia goes even further in touting the benefits of tetrapods. "By improving their shapes and adding alternative values, we can make wave-dissipating blocks attractive habitats for crabs and seaweed," says the site.

Such enthusiasm for tetrapods suggests that the author of this Wikipedia entry is a tetrapod fan, perhaps even an industry insider.

But Fudo Tera Corporation and others in the coastal armoring industry do not usually produce tetrapods themselves. Rather, they lease huge steel molds to customers who pour concrete into the molds and cure the blocks on site. This reduces the expenses that would be incurred pouring the concrete at one location then shipping the blocks to another.

Although the Japanese Government and Japan's construction industry have had an unnatural passion for concrete since the 1950s, concerns have grown steadily that Japan is paying too high a price for its years of excessive concrete use.

Coastal armoring is seen as essential in some areas to protect transportation links, industry and residential areas, but in many areas it is unnecessary, and can even be harmful to the environment and unsafe for the public.

Tetrapods and other types of armoring can cause more damage than they prevent because they alter ocean currents and disrupt the natural cycles of erosion and deposition that naturally form and reshape coasts. Concrete coastal installations can also be lethally dangerous to swimmers and surfers, as well to shipping and recreational boaters.

But probably the greatest cost Japan pays for its years of prodigal concrete use is the loss of priceless coastal scenery. Kerr notes with revulsion the environmental destruction that has taken place nationwide in pursuit of economic growth. "Japan has become arguably the world's ugliest country," he asserts.

Trying to figure out how much concrete is used annually in Japan is extremely difficult because the contents of concrete can vary considerably from project to project. However, a key component of concrete is cement, and according to research by Ouchi Masahiro, an Associate Professor at Kochi University, the peak year for cement production in Japan was 1991, which coincided with the last gasps of Japan's infamous Bubble Economy. In that year Japan used over 80 million tons of cement.

Since then production has fallen 20 percent or more.

Nevertheless, in 2000 Japan produced about twice as much cement per capita as the global average, and between 1920 and 2000 Japan was one of the highest producers of cement in the world per capita, surpassed only by Switzerland and Italy.

It's not clear how much cement has been cast into tetrapods and scattered along Japan's coast, but one thing IS clear: An incredible percentage of Japan's shoreline has been accessorized with concrete walls, blocks and tetrapods.

Figures differ, but government sources generally claims that Japan's coastline is about 35,000km long. The Japanese Government also categorizes its coastline into four types: natural coastline; semi-natural coastline (coastline that is partly altered by roads, concrete and wave-dissipating blocks, but remains in its natural state between ebb and flood tide); artificial coastline; and, estuaries.

Estuaries make up 316 km of Japan's coastline, the natural coastline totals 17,660 km, semi-natural coastal areas make up 4,358 km, and, artificial coastal areas total 11,212 km, for a total of 33,573 km (like we said, figures differ), according to a 1996 survey by the Ministry of Land, Infrastructure and Transport.

When we combine the artificial and semi-natural coastline figures we find that 15,570 km of Japan's coastline has been completely or substantially altered: a total of nearly 50 percent.

Other sources put the percentage even higher. Kerr writes that, by 1993, 55 percent of the entire coast of Japan had been altered by concrete in one form or another.

The Japanese Government claims to have begun removing some concrete in pursuit of an UTSUKUSHII KUNI -- beautiful nation -- policy aimed at reducing armoring on designated coasts. (This policy began several years before Prime Minister Abe launched his own "Beautiful Japan" policies.)

Beginning in 2004, the government reports a 3-year budget to remove wave-dissipating blocks from nine coastal areas to preserve more of Japan's coastal scenic beauty. Central government spending on this project totaled 56,407,000,000 yen in 2004, 52,995,000,000 yen in 2005, and 51,401,000,000 yen last year, according to the Ministry of Land, Infrastructure and Transport (MLIT).

However, pinning down which coasts have been designated and how much work has been done proves much more elusive. We were only able to confirm that Manazuru Harbor in Kanagawa and Takahama Harbor in Kumamoto were to have all their concrete blocks removed by this year.



Ukiyo-e print of Manazuru Harbor by Tsuchiya Koitsu (1870-1922)

Whether in pursuit of a Beautiful Nation policy or for ecosystem sustainability, Japan is sorely in need of a comprehensive coastal preservation and conservation policy.

But Japan is not the only country worried about its crumbling coastline.



Exporting tetrapods. A tetrapod breakwater offshore at Male, capital of the Maldives. The plaque notes that Overseas Development Aid from Japan provided the tetrapods.

According to experts, coasts worldwide are in flux. "Around the world there are some spectacular examples of the damage caused by retreating shorelines. And there are equally spectacular examples of the expense to which some governments will go to hold their shorelines in place. More than 80 percent of the world's shorelines are eroding at rates varying from centimetres to metres per year," write Orrin Pilkey and Terry Hume for a 2001 issue of *Water & Atmosphere*, in an

article entitled, The Shoreline Erosion Problem: Lessons from the Past.

Pilkey is a Professor Emeritus of coastal geology at Duke University in North Carolina, and Hume, at the time of authorship, was with the New Zealand National Institute of Water and Atmospheric Research (NIWA).

Recognizing that climate change will bring changing storm patterns and rising sea levels across the globe, it is reasonable to assume that coastal armoring is going to get more common rather than less so, particularly in coastal urban areas.

The challenge is to use hard stabilization in areas where erosion is unacceptable, for example where a highway, railway or human settlement is in danger. Elsewhere, soft stabilization can be used when money allows, and in other areas nature can be left to take its course.

But it is also worth reconsidering why we protect our coasts.

To call erosion a "problem" is to take a human-centered view of natural coastal changes. Beaches exist in a "dynamic equilibrium involving four factors: the supply of sand to a beach; the wave energy (related to wave height); sea-level change; and the location of the shoreline," state Pilkey and Hume.

"Sand is food for beaches," they note, explaining that sand comes from rivers, eroding bluffs, adjacent beaches, and from the continental shelf.

In Japan, where so many rivers are dammed or lined with concrete, sand and gravel are no longer washing downstream to feed beaches. Another reason sand is not circulating naturally to Japan's coasts is that bays and harbors are continually being dredged to clear shipping channels and to provide fill for coastal development projects and harbor islands.

Of course, if sea levels rise dramatically it will not matter how much sand washes down our rivers or how much concrete we slather on our shores. "The rising sea brings each storm a tiny increment farther inland than the preceding storm," note Pilkey and Hume.

And if sea levels rise tens or even hundreds of centimeters, the homes and businesses of millions of people worldwide will be threatened: While only 2 percent of the planet's land area is in Low Elevation Coastal Zones (LECZ), 13 percent of the world's urban population lives in these areas, according to the UN Population Fund (UNPFA).

And in Asia the percentage is even higher: Here, 18 percent of the total urban population lives in LECZs, the highest percentage of any geographic region, according to UNPFA.

So, as sea levels rise due to thermal expansion of the oceans and melting of the polar ice caps, we can assume that nations will be forced to implement some form of coastal triage: Selecting where and how to spend limited resources, which areas to save and which to give over to the waves.

Since it will be nearly impossible to resettle the largest coastal cities, such as Tokyo, these cities are likely to focus on hard stabilization. This is the best way to protect coastal areas and "the bigger the wall the better," note Pilkey and Hume.

Walls, though, are costly, and walling in entire LECZs is not possible, either financially or practically.

And keeping out waves is only part of the problem. As sea levels rise, salt water slowly saturates coastal lands. Securing subways and other subterranean development and protecting freshwater supplies will be other major challenges.

So where we can we will build up and seal out the seas, but in many other areas we will need to find cheaper means.

Soft stabilization is another approach, which calls for fighting erosion in one place by bringing in sand or fill from another. "This so-called beach nourishment 'improves' the beach and also protects buildings while the beach is in place. However, the procedure is costly and only temporary," explain Pilkey and Hume.

Relocation is another option. "Sometimes referred to as retreat, this is the do-nothing (and let houses fall in) or move-'em-back approach. However it is done, this alternative allows nature and the sea-level rise to roll on. Relocation saves the beach and saves shoreline stabilisation costs. However, it can be politically very difficult and it could be financially costly if government is required to purchase land. Also, land is lost," the authors point out.

Perhaps there is also another option, one that Japan is already experimenting with.

Last month the Japanese and foreign media reported that Japanese officials have begun "planting coral" in an effort to bolster Japan's territorial claims. Six colonies of coral were planted around Okinotori Island, about 1,700km south of Tokyo, according to Chris Hogg of the BBC.



Okinotori

In reality, Okinotori is hardly an island; it is no more than a shallow outcropping of rock. But if Japan can ensure that these rocks are called islands, then, under international law, it can extend its control over resources in the area, both in and below the sea.

"The problem is that increasing water temperatures are damaging the coral reef that clings to the rocks and provides much of their land mass. Rising sea levels blamed on global warming are also threatening to engulf them. If that happened Japan would lose its rights to the natural resources around them," explains Hogg.

Thus the experimentation with island making.

If this works, it is likely Japanese officials will attempt similar transplants to numerous other places around the Japanese archipelago.

And if it becomes possible to “grow” coral reefs that help protect Japan’s coasts from wave and storm damage, what will become of tetrapods? Will they one day become quaint cultural artifacts that are dumped offshore to anchor new coral colonies?

Nice to imagine once again seeing uninterrupted stretches of natural coastline, of ragged rocks and gnarled pine trees, of white beaches. Author Alex Kerr would be delighted.

But what of the tetrapodists, those who offer us a unique vision of cement and concrete. Those like like Kobori, the mini-tetrapod maker.

And Kobayashi Ryo, a 39 year-old graphic designer. “Tetrapods are massive and practical but at the same time sexy when you look at their curvilinear beauty. If concrete had a life, I think a tetrapod is the orthodox way that concrete should evolve,” he told us.

Or Ando Tatsuya, a freelance designer. “The figure of a tetrapod is queer but at the same time it looks very sophisticated. Also you can’t see what’s under the numerous tetrapods piled up; it seems like another dimension, mysterious and scary,” said the 30 year-old designer.

Personally, we still prefer virgin beaches, wild and serene, but the lowly tetrapod has taken on new meaning for us.

Yes, our beaches without them would certainly be much better places; but our world without the art and musings they inspire would not.

Ah tetrapods!

Risa Terai provided research for this article.

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