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Civil Engineering & Marine Construction Division
A Leap Forward in Offshore Oil/Gas Development and Bridge Construction

Behind the broad range of business operations conducted by the Civil Engineering & Marine Construction Division of Nippon Steel lies a vast reservoir of expertise in civil engineering and steel application technologies, expertise that the company has acquired over many years of building its own steelworks and those of others.

Supported by a rapid growth in construction investment dating from the late 1960s onward, Nippon Steel expanded the scope of its civil engineering and marine construction operations. These activities ranged from the installation of city gas and waterworks pipelines to the erection of long-span suspension bridge cables and offshore construction work. In 1974, the Civil Engineering & Marine Construction Division was organized as a base for further expanding into these promising growth areas in engineering and construction. Today, this Division promotes the development of projects around the globe that take into account an accurate understanding of the social needs inherent in the fields of energy, resources and national land development, both at home and abroad.

This two-part series (Nos. 303 and 305) highlights the activities of the Civil Engineering & Marine Construction Division and focuses on the following.

No. 303: Offshore oil/gas development
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Feature Story

Operations Map of Nippon Steel's Bridge Building Overseas

- Fabrication bases
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Bridge Building Overseas

Operating Aggressively in the Worldwide Arena

In 1999, Nippon Steel separated its overseas bridge building operations as an independent business sector and made a full-scale entry into bridge construction abroad. By tapping expertise and experience acquired through the construction of the Akashi Kaikyo Bridge, the world’s longest suspension bridge, and other long-span bridges in Japan and abroad, Nippon Steel is aggressively promoting bridge building opportunities throughout the world.

Among the major bridge building projects overseas in which Nippon Steel has thus far been involved are the Japan-Egypt Friendship Bridge over the Suez Canal, the Kwang-Ahn Bridge of Korea which opened to traffic in January 2003, the second Tacoma Narrows Bridge in the U.S.A. and the Runyang Bridge of China which, upon completion, will be the longest suspension bridge in that country.

Overseas Operations Thrive on Domestically Amassed Expertise

In the 1960s Nippon Steel began to grapple with the development of technologies for the manufacture and erection of the main cables used in suspension bridges—specifically methods for manufacturing and erecting parallel wire strands (PWS)* and a new air spinning method.* The PWS method was first used in the construction of the Kanmon Bridge which was completed in 1973. It has since become a primary technology for suspension bridge cabling and has greatly advanced cable erection technologies in Japan. Concurrently with this, Nippon Steel proceeded with the development of a new type of suspension bridge, and other long-span bridges in Japan and abroad.

*Refer to "Advanced Technologies of Nippon Steel" at the end of the current article.
parallel wire strands intended for use in cable-stayed bridges. A result of this endeavor was the New-PWS method,* an improvement over conventional PWS technology. This proprietary technology belonging to Nippon Steel has been applied in many cable-stayed bridges, including the Tatara Bridge, the longest of its type in the world. Always a forerunner in this field, Nippon Steel has thus accumulated an array of elemental cabling technologies.

The completion of the Akashi Kaikyo Bridge in 1998 and the Kurushima Kaikyo Bridges in 1999 marked a major turning point in the history of long-span suspension bridge construction in Japan. In this context, General Manager Hajime Hosokawa of the Bridge Engineering & Construction Div., Civil Engineering & Marine Construction Division, who has thirty years of consistent involvement in suspension bridge projects, says the following.

"Major projects for building long-span suspension bridges in Japan came to a halt for a while. Thinking that the global stage was the next place where Nippon Steel should offer its developmental capabilities, we turned our eyes abroad. For about one and a half years following the completion of the Akashi Kaikyo Bridge, we visited every country around the world that was then at some stage of new bridge construction. As a result, our company received contracts for the Kwang-Ahn Bridge of Korea and the second Tacoma Narrows Bridge of the U.S.A."

Korea's Longest Suspension Bridge

The Kwang-Ahn Bridge in the city of Pusan measures 900 m in total length and has a center span of 500 m. Opening for service on January 6, 2003 as the longest suspension bridge in Korea, it was the first overseas long-span suspension bridge project in which Nippon Steel participated. In accordance with a contract concluded in 1999, Nippon Steel assumed responsibility for planning the work execution program, for providing field guidance regarding cable erection and girder work and for leasing the special equipment needed for cable and girder erection.

As Project Manager of the Kwang-Ahn Bridge Project, Manager Moritoshi Yano of the Bridge Engineering & Construction Div. says in retrospect, "This bridge project..."
came to completion through many twists and turns. It is worth noting that Nippon Steel received orders for not only the cable work for which the company boasts an extensive domestic track record but for the girder work as well, an area in which we had no domestic work history. This subsequently led to the company receiving contracts for the second Tacoma Narrows Bridge and the Runyang Bridge, which in turn provided Nippon Steel with the opportunity to make a great leap forward. Since it was our first overseas project, we had to grope our way at first. We came to fully realize that the most important yet difficult task in doing business abroad is to maintain good communications with our foreign partners.”

Succession of Large-scale Orders Attests to High Capabilities

After receiving the order for the Kwang-Ahn Bridge of Korea, Nippon Steel won orders in rapid succession for the second Tacoma Narrows Bridge with a total length of 1,646 m (center span of 854 m) in Washington, U.S.A., and for the Runyang Bridge with a center span of 1,490 m that will traverse the Yangtze River in China. Thus, Nippon Steel has been involved in the construction of the longest suspension bridges in Japan, Korea and China.

The second Tacoma Narrows Bridge is unique insofar as it is to be built parallel to the existing Tacoma Narrows Bridge to relieve traffic congestion. The construction of the bridge was subcontracted in August 2002 to Nippon Steel jointly with Kawada Industries, Inc. through the prime contractor, a joint venture between Bechtel Infrastructure Corp. in San Francisco and Kiewit Pacific Company in Vancouver. Specifically, Nippon Steel will be responsible for the manufacture and construction engineering of girders and cables and for the leasing of cable and girder erection equipment. The bridge is due to be completed by the end of 2006. Nippon Steel will also
serve as a supervisor during the period from 2005 through the completion of the bridge.

The Runyang Bridge (total length: 2,430 m and center span: 1,490 m) is now being built across the Yangtze River and, upon completion, will be the world's third longest suspension bridge. Nippon Steel is responsible for construction engineering and field supervision and for the supply of protective S-shaped wrapping wire* which is being used on cable for the first time in China. Sixty percent of the cable manufacturing work was contracted to Jiangsu Fasten-Nippon Steel Cable Co., Ltd. As a joint enterprise between Nippon Steel and a major Chinese cable-wire maker, this company was established in 2001, prior to the implementation of this bridge project.

Group Leader Shinichi Konno of the Bridge Engineering & Construction Div., who was stationed in China for about one year for the start-up of the joint enterprise, says, "Indeed, our new joint enterprise has no track record in the field of PWS. It was, I believe, the high reliability of the Nippon Steel brand that enabled such a latecomer to compete favorably with its many predecessors in the market and to win a contract for such a massive share of the cable manufacturing work. High on the wish list of our partner in arriving at the joint venture was not our funds, but our technology. The transfer of Nippon Steel's experience and know-how was highly rated."

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Boldly Meeting the Challenges of New Projects

"Once we have accomplished good results in one place, that will then become a focus of information for peripheral areas from which to expand our business operations," says General Manager Hosokawa of the Bridge Engineering & Construction Div. "We hope that the results of the second Tacoma Narrows Bridge will produce future developments in the United States. Beyond that, another of our future aims is to realize the world's longest bridge over the Strait of Messina in Italy."

The Strait of Messina Bridge, which is currently in the planning stage, will connect the Italian mainland with the island of Sicily. When realized, it will be the world's longest suspension bridge with a total length of 5,070 m and a center span of 3,300 m. It will be about 1.7 times as long as the Akashi Kaikyo Bridge in terms of center span length. It is said that the total mass of the cables for the Strait of Messina Bridge will reach approximately 170,000 tons, compared to 50,000 tons for the Akashi Kaikyo Bridge. Consequently it is said that securing a stable supply of cables together with reducing their mass will be one of the most challenging tasks of the project.

In discussing his attraction to long-span suspension bridges and his desire to build them, General Manager Hosokawa comments, "My dream is to break through the many technical problems and realize the world's longest bridge, the Strait of Messina Bridge. In general, since ninety percent of cable erection consists of on-site work, the key to executing this work is to fully utilize the know-how of the field engineers. This is the real attraction of building long-span suspension bridges. It is necessary that field staff members promote collaboration among themselves in carrying out their assignments. On-site project management capabilities are of prime importance."

One hundred and twenty years have passed since the Brooklyn Bridge, the world's first modern suspension bridge, was completed in 1883. During this period, however, no more than one hundred modern suspension bridges have appeared in the world and only a dozen or so companies have been involved in the construction of long-span suspension bridges.

"In a market where specialized and advanced technological capabilities are required, our most important theme remains to be our continued effort to nurture competent engineers and to establish a more extensive track record in bridge construction—thereby boldly meeting the challenge of ever lengthening long-span suspension bridge construction the world over," adds General Manager Hosokawa.
Advanced Technologies of Nippon Steel in Long-span Suspension Bridge Construction

Parallel Wire Strand (PWS) Cables

High-strength zinc-coated steel wires are fitted parallel to each other and bundled without twisting and then cut to a specified length to form a parallel wire strand. A socket is then attached to each end employing zinc-copper alloys. Shop-fabricated PWSs are drawn out and formed one by one and are finally made into cables at the construction site. The PWS method reduces the erection period compared to the air-spinning (AS) method and has therefore been used in the construction of most long suspension bridges in Japan. For the Akashi Kaikyo Bridge, the world's longest suspension bridge, two main cables with a diameter of 1,122 mm were erected. Each cable consisted of 290 PWSs and each of these contained 127 steel wires.

New-PWS Cables

High-strength zinc-coated steel wires are factory-fitted in parallel and bundled to form cables. After the application of polyethylene protection, the cable is cut to a specified length and fitted with a high fatigue-strength socket at each end. New-PWS cables are used to support cable-stayed bridges, arch bridges and suspended roof structures.
S-shaped Wrapping Wire

Zinc-coated S-shaped wire is wrapped in a twisted state around the outer periphery of cables to provide corrosion protection. Before the development of S-shaped wire, round wire was used for wrapping. Round wire allowed gaps to form due to cable expansion and this in turn permitted water penetration. S-shaped wrapping wire, developed by Nippon Steel, has an S-shaped cross section and is wrapped around the cable in such a way as to be self-engaging. The resulting flat surface is free of gaps even when cable expansion occurs, thereby greatly improving the corrosion resistance of the cables.

Air-spinning Method

In this method, cable wires are transported to the site where they are repeatedly spun one by one while being joined and fitted to form a cable. This method was first adopted in the construction of the Brooklyn Bridge which was completed in 1883 in New York. Nippon Steel added improvements to the original method to develop a new air-spinning (tension control) method. This was adopted for use in the Hirado Bridge and the Shimotsui-Seto Bridge. The new air-spinning method has become a mainstay in the construction of suspension bridges overseas, such as the Great Belt East Bridge in Denmark, the world's second longest suspension bridge. Because this method fabricates cable by drawing out the wire at the job site, it prolongs the construction period. Because of this, the PWS method is the primary cable erection technology used in Japan.