In this issue

Feature Story

Vibration-control and Seismic-isolation Technologies by Nippon Steel (Two-part series: 2)
Vibration-control and Seismic-isolation Technologies Forge ahead with an Eye towards Further Evolution.

Operating Roundup

Forecast for Consolidated Operating Performance in 1st Half of FY 2005
Consolidated operating results for the first half of fiscal 2005 are forecasted (approximate figures): sales of ¥1,840 billion, operating profits of ¥275 billion and a net income of ¥180 billion.

Bongkot Field Development Project Phase 3E
Nippon Steel have been recently awarded by PTT Exploration and Production Public Company Limited an EPC contract to construct three offshore platforms and associated offshore pipelines for Bongkot Gas Field located in Gulf of Thailand.

Sisi Nubi Phase 1 Project
PT Nippon Steel Construction Indonesia, a subsidiary of Nippon Steel, has been recently awarded by Total E & P Indonesie an EPC contract to construct three offshore platforms for Sisi and Nubi Gas Field located in East Kalimantan, Indonesia.

Joint-Venture Production of Cast Rolls for Steel Rolling
Nippon Steel and Sumitomo Metal Industries, Ltd. have agreed on the consolidation of the production and sales of cast rolls for steel rolling between the two companies' wholly-owned subsidiaries.
Feature Story

(Two-part Series: 2)

Vibration-control and Seismic-isolation Technologies by Nippon Steel

—Substantially Reducing Earthquake Damage to Buildings—

The “Unbonded Braces” developed by Nippon Steel were recently awarded the Ichimura Industrial Award (Contribution Award), a prominent award in the field of technological development in Japan. In light of the frequent seismic activity found in various regions of late, the ability of this technology to reduce earthquake damage to buildings in a manner that ensures their continual use has received particularly high appraisal. This feature is a step ahead of the idea underlying the current Earthquake-Resistant Design Codes (introduced in 1981) that emphasize the preservation of human life and the prevention of building collapse.

This two-part series (nos. 333 and 334) highlights the Unbonded Braces and other vibration-control and seismic-isolation technologies of Nippon Steel that are gradually gaining greater recognition in Japan and elsewhere.
Feature Story

Vibration-control and Seismic-isolation Technologies Forge ahead with an Eye towards Further Evolution

Unbonded Braces and Visco-elastic Dampers: Resistant to Vibration Caused by Either Earthquakes or Wind

The Unbonded Braces are representative of hysteretic-damping products for passive controlled structure by Nippon Steel. They are easily installed in a diagonal pattern between beams, columns and other members, completely answers the need for freedom in the structural configuration of buildings and, at the same time, damps vibrations during an earthquake.

Group Manager Yasuhiro Nakata, Earthquake Engineering and Marketing Group, Steel Structure Div., Building Construction Division, Engineering Divisions Group, says of the specific features of Unbonded Braces, “The product performances required to damp seismic vibrations were designed by Nippon Steel and have been further standardized. Accordingly, users can apply Unbonded Braces, the latest type of hysteretic-damping steel products, in a semi-order made form in conformity with the need for respective buildings.”
Feature Story

It is the visco-elastic hysteretic damper (Fig. 1) that has been developed by pushing the concept of Unbonded Braces. In high-rise building construction, not only seismic resistance but also the mitigation of vibrations caused by wind has become important requirements.

Wind vibration continues longer than seismic vibration. Accordingly, when vibration energy is to be absorbed by means of the plasticity inherent in steel products, metallic fatigue is liable to occur. To solve this problem, Nippon Steel, jointly with Sumitomo 3M Limited, has developed a structural member that not only maintains its structural strength while simultaneously absorbing vibration but is also highly resistant to metallic fatigue. This achievement has been made by alternating the placement of steel products and visco-elastic materials like a rubber. This visco-elastic member demonstrates an ability to damp vibration caused not only by wind but also by earthquakes of wide-ranging intensities, from minute to major.

“Nippon Steel has an extensive accumulation of technologies that mitigate vibrations and possesses know-how regarding steel structure construction. However, because there is now a need for know-how regarding non-steel materials and visco-elastic materials that are easy to handle, the company joined forces with Sumitomo 3M, a company with much know-how in this field, to successfully develop the visco-elastic damper, the world’s first damper of its type. Guiding the work was Professor Akira Wada of the Tokyo Institute of Technology. Highly reliable and high performing, this damper can resist even major earthquakes.” (Nakata)

An application technology associated with automobile shock absorbers, oil dampers have been extensively used to control vibrations that last many cycles, e.g. those caused by wind. However, their fabrication process is complicated and the production cost is high.

Manager Hiroaki Konishi, Earthquake Engineering and Marketing Group, stresses cost performance, “The manufacture of Unbonded Braces and visco-elastic dampers involve a simple fabrication process and production costs that are less than half of those of oil dampers. This cost performance has been realized simply by fully utilizing the characteristic performances peculiar to the materials.”
Nippon Steel has been involved with seismic-isolation technology from an early stage. The technology reduces the input of seismic energy in a building and suppresses the strong vibrations that work internally by installing dampers and rubber bearing between a building and its foundation structures. The dampers act to absorb seismic energy while the rubber bearing offers horizontal stability and flexibility as it supports the great weight of the upper structure.

“In the mid-1980s, we started a joint study with then Professor Hideyuki Tada of Fukuoka University on a seismic-isolation device that combined the use of rubber bearing and steel products.” (Nakata)

This seismic-isolation device, installed between a building and its foundation structures, absorbs and then dissipates seismic vibration energy. However, in the event of a major earthquake, the amplitude due to vibration is sometimes as much as 1.0 m.

On the other hand, the plastic deformation capacity of steel against tension is about 1.2 times the length of the steel member applied. But because a large deformation capacity of about ±50 cm in the horizontal direction is required of a seismic-isolation member, a steel product alone is not adequate. To remedy this, Prof. Tada devised the concept of steel dampers in which the constituent bent steel damper members were arranged in a petal-like configuration to adhere to such a large amplitude and thus to efficiently dissipate vibration energy.

“In those days, the Building Construction Division jointly with the company’s steelmaking department had already commenced the development of steel products for use with dampers. Combining this steel technology with Prof. Tada’s concept, the Division successfully perfected the steel bar damper for seismic-isolation that employed round steel bars, the first of its kind in Japan, and put it on the market. Large deformation simulations of rubber bearing were carried out by means of FEM (finite element method) programs run on large-capacity computers, which were rarely used by private companies. This greatly contributed to the practical use of these rubber bearing.” (Nakata)

Meanwhile, seismic-isolated structures failed to see extensive use in the initial stages of development. This was because seismic-isolated structures were not specified in the Building Standard Law of Japan and because, further, it was necessary for every building construction project to obtain approval from the Minister of Construction, which was a complicated process. However, the Great Hanshin-Awaji Earthquake verified that buildings employing seismic-isolated structures suffered almost no damage. Since then, seismic-isolation technology has attracted attention and its applications are steadily increasing.

Nippon Steel has developed two types of seismic-isolation dampers. One is the U-shaped steel damper (Fig. 2) featuring high performance and low cost. It can be installed in narrow spaces because the damper configuration is simplified to a U shape and the dampers are arrayed in a radial manner. The other type is rubber bearing with the U-shaped steel damper (Fig. 3), in which the rubber bearing and the U-shaped steel damper are integrated to reduce handling during construction.
Along with the steady institution of related laws, the revision of the Building Standard Law in 1998 and the enactment of the notification in 2000, it is now possible for seismic-isolated buildings to gain construction confirmation without approval by the Minister of Infrastructure, Land and Transport, thereby leading to the ready use of these structures in building construction.

“Nippon Steel is attempting to broaden the use of seismic-isolation technology and to support education about it through the Japan Society of Seismic Isolation, which the company helped to establish. Seismic-isolated structures have already been adopted in the construction of diverse buildings, such as hospital buildings that constitute an important base of operation after a disaster, computer centers and apartment buildings. The cumulative number of buildings employing these seismic-isolated structures amounts to about 1,000 nationwide (Fig. 4). In the recent Niigata-Chuetsu Earthquake and the Fukuoka Seicho-Oki Earthquake, seismic-isolated structures proved their high performance and are expected to expand into the fields of detached houses and general buildings.” (Konishi).
Fig. 4 Construction of Seismic-isolated Buildings

No. of buildings

<table>
<thead>
<tr>
<th>Year</th>
<th>0</th>
<th>50</th>
<th>100</th>
<th>150</th>
<th>200</th>
<th>250</th>
</tr>
</thead>
<tbody>
<tr>
<td>1982</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1984</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1986</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1988</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1992</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1998</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data to 2001 (including estimates)

Source: Japan Society of Seismic Isolation

Application of rubber bearing with U-shaped steel damper
Kimitsu Chuo Hospital (Chiba, 2001)

Application of seismic-isolation steel bar damper
Computer center (1991)
Feature Story

Concerns Emerge in Earthquake-prone Taiwan and the U.S. West Coast

To compliment the domestic market’s favorable trend in Unbonded Braces and visco-elastic dampers, Nippon Steel is actively promoting these products overseas. It is particularly in Taiwan and the West Coast of the U.S.—earthquake-prone areas similar to Japan—that the company is concentrating its marketing efforts.

Manager Toyoki Kuroiwa, Earthquake Engineering and Marketing Group, is in charge of marketing in Taiwan and describes these marketing operations thus: “We started marketing Unbonded Braces and visco-elastic dampers in 2000. At that time, the concept of vibration control and seismic isolation was not yet circulating among architects and structural engineers in Taiwan and we had considerable difficulty in marketing the idea. But, now, the general public of Taiwan clearly recognizes how terrible earthquakes can be, and in addition, that nation has begun own development of vibration control technology. Given this situation, inquiries to our company have rapidly increased in the last two to three years.”

Noting that such growing concern about vibration control and seismic-isolation technologies is deeply related to various conditions inherent in Taiwan, Kuroiwa points out, “As in Japan, land space in Taiwan is limited and high-rise condominums are being built in increasing numbers, mainly in urban areas. In fact, developers have increasingly adopted the vibration control and seismic-isolation technologies as an important sales tool when selling condominiums.”

However, the commonly accepted division of labor in Taiwan is such that the development of vibration control and seismic-isolation technologies is undertaken by universities and other research institutes, seismic design by structural engineers and the manufacture of structural members by steel fabricators. This system seems rational on the surface, but there are no organizations that can provide comprehensive support at every level: from development to design and construction, and, further, to the improvement of technologies.

“Competition in the vibration control and seismic-isolation market is now fierce in Taiwan. Within this environment, Nippon Steel’s technology...”
has gained high marks and is regarded as very reliable. This is due to the strength of the company’s comprehensive range of capabilities that extends from product development and design to actual building construction—capabilities that rank among the top tier of competing companies in Japan, which is the world’s most advanced nation in terms of earthquake countermeasures.” (Kuroiwa) Meanwhile, Unbonded Braces have breached the West Coast market in the U.S.

“The American construction industry is unexpectedly conservative and careful in its approach to vibration control technology. We are actively promoting Unbonded Braces as having excellent cost performance and being easy to adopt. Hospitals in the State of California are obliged to provide their buildings with a certain level of seismic-resistance reinforcement by 2008. Because Unbonded Braces are suitable for such reinforcement, we consider this an excellent chance for market promotion.” (Nakata)

With the adoption of vibration-control and seismic-isolation technologies in buildings, not only will the asset value of each building be maintained in the event of a major earthquake. The disaster-preventive capacity of the city as a whole will also be enhanced while simultaneously improving safety. From the aspect of such societal needs too, Nippon Steel intends to further promote the broader adoption of dampers for passive controlled structure and seismic-isolation dampers both at home and abroad.