TOKAI SPRING

TOKAISPRING

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As long as there is a need for just one spring

Tokai spring is committed to manufacturing small-lot and custom-made spring orders because we believe that there are customers who need highly specialized, high quality spring products.　Tokai spring's mission is satisfying or even exceeding our customer's requirements.

Tokai spring protects the world's tallest broadcasting tower from severe forces of nature.

The 634meter TOKYO SKYTREE® is the tallest free-standing broadcasting tower in the world. This tower has to withstand severe forces of nature, such as wind, rain, snow and earthquakes.

The gain-tower that is at the very top of the Tokyo Skytree transmits TV signals of digital terrestrial TV broadcasts as well as smart phone signals. The gain-tower itself is almost 140 m tall, as high as a 30-story building. A gain tower of this scale is constantly exposed to various forces of nature such as wind, rain, snow and even earthquake vibration.

TOKYO SKYTREE® was designed to withstand gale force winds of up to 110 m/sec, which is estimated to happen once in 1300 years. However, even wind speeds of 10 to 15m/sec can create a resonance phenomenon called "vortex induced vibration". Vortex induced vibration can sometimes cause violent swaying of the tower as well as structural damage.

At the very top of the gain-tower, vibration damping devices called "TMDs" are installed to mitigate vortex induced vibration. This advanced vibration damping technology was made possible with Tokai spring's fitting type springs (compression and tension springs). A single fitting spring can mitigate both 〝push〟 and 〝pull〟 forces, so that it can dampen any type of vibration.

The springs used are exceptionally large, weighing almost 800 kg each. When you visit TOKYO SKYTREE® we hope you will keep in mind that Tokyo's new landmark, built to herald Japan's new age of broadcasting, is sustained by our fitting type springs mounted 620 meters high above Tokyo's skyline.

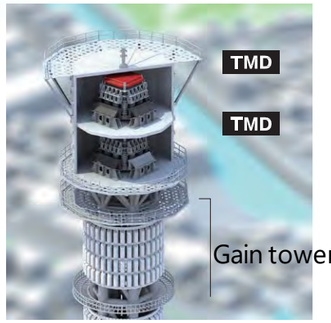
PROJECT STORY

Tokai spring has a track record of supplying compression and tension springs for large scale TMDs, such as in the buildings of major domestic and overseas airports and high-rise smokestacks. It was our experience and expertise that helped us to secure the this project. However, Tokyo Skytree was a combination of unprecedented structure and size and we could not use ordinary development methods. The challenge was to assure the fitting of springs that will not detach even under the most severe physical forces. With fittings normally used by Tokai spring, the spring's free length increases which can potentially cause buckling.
We developed a special spring production method that enabled us to decrease the free length and succeeded in developing a fitting that would not disengage under severe conditions. We revised the engineering drawing of the spring many times to meet the required specifications before completing the final design.

Vibration control devices called tuned mass dampers, "TMDs"

are applied to buildings or machines that require vibrations control. The devices use a damper and spring to optimally adjust, or 〝tune〟 the natural frequency of a mass. The Tokyo Skytree® cannot afford to have even a brief interruption in its operation. Usually a single device would sufficiently control the vibration of the gain-tower but for this reason, two TMDs totaling 65 tons in weight were installed.

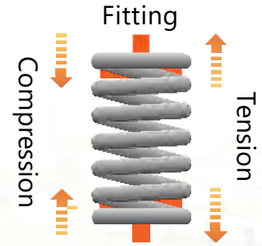
TOKYO SKYTREE®



HERE!

Gain tower

Fitting-type springs
[Compression and tension springs]



By attaching fittings on both ends, a single spring is capable of handling both compression and tension forces. The spring used here has an outer diameter of roughly ϕ600 mm, a height of 1200 mm, and weighs about 800 kg each. Each TMD fitted to the TOKYO SKYTREE® has four compression and tension springs, with the rigidity of the springs used to set and adjust the vibration period of the TMDs.

What is 〝vortexinduced vibration〟 ?

Tacoma Narrows Bridge in Washington State was considered to be the most technologically advanced bridge of its time when construction was completed in 1940 . The bridge collapsed by vortex induced vibration with wind speed of less than 20 m/second, a resonance phenomenon occurring in the surroundings or at the reverse sides of bridge structures. If the vortices that occur have a vibration frequency that matches those of the structure itself or its components, violent vibrations can occur even at low wind speeds.

Tokai spring launches Japan's aspirations of space exploration

In the past, all rockets launched by Japan used parts made in the U.S. However, the birth of the Japan.Aerospace Exploration Agency (JAXA) greatly changed the direction of Japan's space industry. JAXA's new mission was to build rockets exclusively of parts made in Japan. Developing high-precision springs was a critical element of this mission.

The International Space Station (ISS), in low Earth orbit at around 400 km above the Earth's surface, is a giant experimental facility roughly the size of a soccer field. In this station, 15 participating countries, including Japan, engage in experiments and research that utilize the special outer space environment, and in the observation of Earth and celestial bodies. To transport food, supplies, and the equipments required for the experiments to the astronauts stationed at the station, JAXA developed the space station supply vehicle named "Kounotori". The Kounotori is launched aboard the "HII-B Rocket", the largest rocket manufactured in Japan by Japanese companies. The rocket marked its third successful launch and supply mission in July 2012 and the achievement was highly praised internationally.

Tokai spring was used in the HII-B Rocket's engines and in its fairing; the component that houses the Kounotori vehicle. These springs are able to function even when subjected to the tremendous forces that occur during a launch, as well as in the absolute zero (roughly -270 degrees Celsius) temperature of outer space. Tokai spring applied its technical and engineering expertise to develop and produce specialized springs for the rockets and fairings. A symbol of pride for the Japanese aerospace industry, the successful launch also greatly raised hope for future space missions among the people of Japan. Japanese space technology will continue to evolve to ultimately achieve manned space flight into space and Tokai spring technology will be a critical part of this development by providing high performance springs.

Main engine to launch the largest rocket in Japan

First-stage engine

The two-stage rocket uses liquid oxygen and hydrogen as its fuel, with 4 solid rocket boosters (SRB-A) mounted on four sides of the main body to assist its propulsion. This configuration enables H-IIA rockets the maximum payload.

Satellite fairing

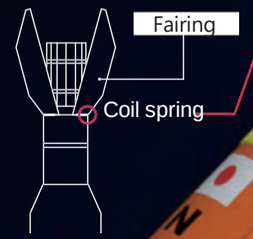
HII-B Rocket

shields the satellite and supply vehicle from shock waves and air pressure.

The cover protects the Kounotori vehicle and safely deliver it and its payload into space. When the rocket reaches an altitude at which there is no effects from earth's atomosphere, the satellite fairing is cast away and the payload satellite is separated from it.

Cold-formed coil springs HERE!

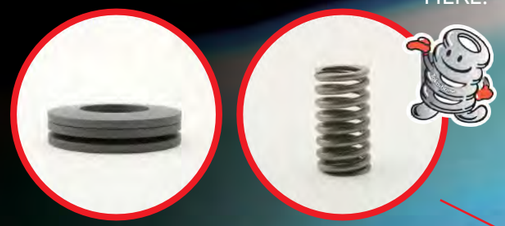
Once rockets reach the target altitude, the satellite fairing is split into two by the operation of a coil spring and is cast away. The Kounotori vehicle which emerges from within, separates and once again uses the operation of springs to achieve its intended orbit. These springs are made of high-stress materials so that it can withstand the uniquely challenging environment of space.



PROJECT STORY

A number of research institutions and manufacturers participated in the development of JAXA's rocket, bringing together the best and brightest of Japanese technical and engineering talents. Initially there was skepticism towards using a domestic product for the disc springs in the first-stage rocket engine valves but Tokai spring was able to gain approval with its prototypes. After the approval, independent testing laboratories carried out numerous rigorous performance qualification tests, and our company was able to create a spring guaranteed to operate when subjected to the forces of the launch and the environment of space.

Disc springs and cold-formed coil springs HERE!



Disc spring

Cold-formed coil spring

These springs are installed in regulator valves for the adjustment of helium gas. These springs need to withstand extreme heat during launch and flight within and without the atmosphere. Material used can tolerate the extreme temperature variations during the mission.

MADE IN JAPAN, soaring into outer space

Tokai spring super high-precision springs sustain power plant turbines at the heart of energy production.

Electric power cannot simply be drawn from thermal or nuclear power as is. Rather, power generation requires a machine known as a 〝prime mover〟 to convert heat energy into mechanical energy. In power plants, this crucial role is played by g as turbines and steam turbines, whose work is in turn supported by springs.

Energy from high pressure gas and high pressure steam, created by thermal and nuclear power, can only be transmitted to generators after it generates rotary motion through turbines. Turbines are machines containing bladed rotors which operate much like the vanes of a windmill. However, turbine rotors are not moved by the wind, but by high temperature, high pressure gas and steam created from an enormous amount of energy. To achieve efficient use of energy, turbines have to withstand enormous temperature and pressure. This task is performed by Tokai spring's leaf springs. Acting as cushions for the contact between rotors turning at high speeds and components called 〝seal rings〟 which prevent steam leaks, these springs serve to protect turbines and achieve stable and enhanced power generation.
People do not see flat plate springs often in their daily lives, but these springs play a crucial, behind the scenes to maintain our society's energy supply.

PROJECT STORY

Steam and gas turbine springs are consistently exposed to very high temperatures. The maximum temperature a turbine spring can withstand is determined by the material used for the spring. There is a variety of heat-resistant steel materials available but only a small number of materials can satisfy the required properties to bend and then recover its original shape. That is why Tokaibane is committed to continuously investing and researching in the development of new production technologies such as heat treatment methods which brings out the characteristics of a spring in normally heat-resistant steel, or whatever other performance properties our customers .

Seal rings

-Enhancing the performance of turbines-

Seal rings close off gaps in turbines and prevent the leakage of steam. This allows the flow of steam to be efficiently transmitted to the rotor blades, achieving efficient turbine performance.

HERE!

Leaf springs

Disc springs

Leaf springs and disc springs

Strong spinning motion can cause a rotor shaft to be misaligned. If this happens, the springs act as cushions to prevent heavy loads from being exerted even with zero contact between the rotor and seal ring.

What is a turbine?

Steam turbines and gas turbines are known as "prime movers". Turbines have the function of converting various types of energy into mechanical movements. Passing through these turbines, high pressure gas or steam created by thermal or nuclear power can be converted into electricity.

Clearance control for starting/stopping and load operation

The rotor's optimum clearance in a turbine is different at starting, during and at stopping point of operation and an adjustment is essential at each point for maximum performance.

Chair skiing

Chair skiers request custom-made springs tailored to their requirements. They do not use chair skis fitted with off the shelf springs.

Rough terrain vehicles

Rubber-tread crawler vehicles operate on rough grounds such as mountains and snow covered terrain. Springs are incorporated into their treads together with cylinders, to prevent treads loosening or disengaging.

Hayabusa

In 2010, the Hayabusa satellite completed its 6 billion km journey and returned to Earth. Many springs are used in the Hayabusa, including in its sampling devices which were used to collect material samples from the surface of the Itokawa asteroid.

Gondola lifts

Gondola lifts require an extremely high level of quality and safety. Springs are used in components that clamp securely onto gondola ropes, ensuring safety even under blizzard conditions.

Sluice gates

Devices known as "Gate-robo" are used to maintain the safety of sluice gates and to monitor the operations continually to prevent abnormal forces being applied to the ropes in them.

Ironworks and steelworks facilities

Custom made springs are used in various stages of steel production, from sizing presses to large crane presses, playing important roles in large-scale manufacturing.

Machining centers

Main axis disc springs are fitted to respond to the constantly-changing conditions of machining centers, such as shifts to high-speed axis rotation or increases in ATC frequency.

Ferris wheels

Custom made springs are used to stabilize the drive components that rotate the largest ferris wheels in the world.

Tower buildings

Fitting-type coil springs, which can handle both compression and tension, are used in passive dampers and other components in high-rise structures.

Akashi-Kaikyo Bridge

The 3911 meter long Akashi-Kaikyo bridge is the longest suspension bridge in the world. To ensure the safety of the bridge, spring-type wind shoes absorb vibrations of the bridge caused by winds from various directions and all speeds.

Marine vessel valves

Valves for marine vessels demand high reliability to ensure that they do not fail over periods of extended operation. These functions are aided in the background by springs.

Shinkai 6500

This submersible research vehicle is currently the deepest-diving vehicle in the world. Springs with outstanding corrosion resistance are employed to function in the highly- corrosive environment of the deep sea.

Behind the scenes, Tokai spring's custom made springs support a variety of equipment throughout the world.

Tokai spring can meet any demand in a variety of tasks.

Coil springs

Can be produced up to a max wire diameter of 90mm, max outer coil diameter of 600mm and max free length of 1200mm!

Disc springs

Support up to a max outer diameter of 600mm and max test load of 300t! These springs excel at delivering large forces in small spaces.

HII-B Rocket P5

i-MC springs

i-MC spring for a machining center.
These springs are able to accomplish high speed rotation stability and long life by the high dimensional accuracy.

Leaf springs

These are springs in flat plate form which are used in highly diverse applications, from stacked flat springs in trucks and railway vehicles, to extremely small springs incorporated into electronic devices.

Power Plant Turbines P.7

Ring springs

Springs with a structure that combines alternating inner and outer rings. They can absorb large amounts of energy with small volume dimensions.

Tension springs

Can be produced with a wire diameter up to 30mm. Ideal for use with high loads.

Fitting-type springs

By inserting screw-type fittings into both ends and using rod ends, or similar items depending on the conditions of application, these springs are able to handle both pushing (compressive) and pulling (tensile) forces.

TOKYO SKYTREE® P.3

Rectangular wire springs

Compared to standard round cross-section coil springs, these remain constant even in small spaces.

"Gate-robo"

Safety devices used in sluice gates on dams and rivers. They constantly monitor whether abnormal loads are being applied to ropes when sluice gates are operated.

Spiral springs

Forces are generated in the rotational direction with minimal space. Manufacturing this type of spring requires advanced winding techniques by skilled craftsmen.

Conical springs

Their conical shape reduces bowing, and their closed height can be decreased depending on their shape, allowing them to be used in compact spaces.

Volute springs

This is a powerful spring with the characteristics of 2-stage springs. They are often used in crane ends subjected to high impacts and in cushioning equipment in ironworks and steelworks facilities. The springs are hand made by skilled craftsmen.

Torsion springs

These springs are made by undergoing a twisting force(torque) around their coil axis. They can store a higher amount of energy than coil springs with the same weight, making lightweight design possible.

Tokai spring will custom make any type of spring to meet the required properties of your application.

Tokai spring provides high quality customer support for all custom made small lot orders.






Technical Service

Tokai spring can provide technical support to meet your needs!

If you have a project which requires possible by our design support that is coordinated with our close coordination and discussion to develop a highly specialized application ofsprings, Tokai spring can provide the technical service to support your project.

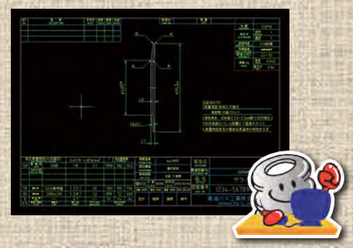
Design support system"Uncle"

Tokai spring maintains database of all our past technical developments and design information.

After receiving an inquiry or order from a customer, our first step is to confirm the details of the design.

We have entered all of the design drawings for our past work into an in-house database,

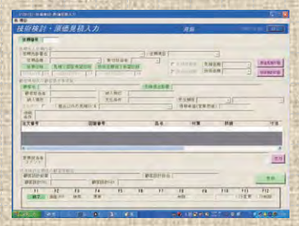
and after searching for any drawings that could be of useful reference for the specifications of an order, we will be able to confirm any items requiring investigation and create a new design. This process is made possible by our design support system,"Uncle." All of the know-how we have accumulated can be valuable resources for the production of new springs.



Sales support system "Tascal"

Constantly finding the best prices from design specifications.

Our "Tascal" system allows us to quickly propose the best prices and delivery dates to our customers.



This system is linked previously-submitted quotations, so it can search them to determine when and at what price a spring with the quality required by a customer can be delivered. It is a reliable sales support system that is coordinated with our Design and Production Departments to reflect all relevant information in price quotations without any delay.

Simple repeat ordering system "REORDER"

All order histories can be checked on customized website for individual customers.

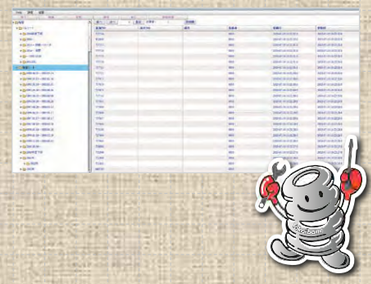
We have prepared a dedicated website for our customers where they can confirm the specifications and product information of all orders that they have placed in the past. This provides added convenience allowing customers to use past orders as a reference when they wish to Reorder.

*Please inquire with us about on the use of this system.

Quality management principle

Tokai spring has been Producing springs for over 30 years with the same principle of quality management.

Final production drawings, detailed technical information and delivery schedule must be considered in the manufacturing process.
Information on all our manufactured springs is kept in our database so that we can remanufacture springs we manufactured in the past to exactly the same quality standard, or to up-graded specifications.



Research and development

Striving to fulfill customer needs with technology oriented solutions through comprehensive verification experiments, examinations and analysis.

Disc spring fatigue testing equipment

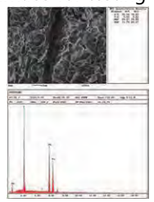
Endurance testing

These tests include relaxation tests and compression fatigue tests. They are used for verifying the reliability of our springs and in the research and development of springs with an even longer life.

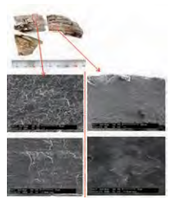
High-temperature heating furnace for testing

Environmental testing

These tests simulate a variety of different conditions including low temperature, high temperature, high humidity, and corrosive environments.



Composition analysis

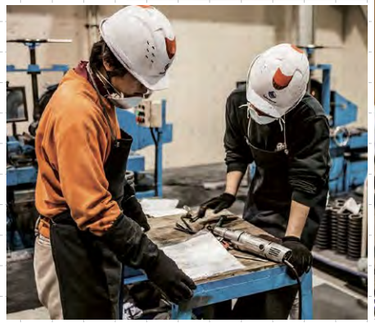


Microscopic observation

Failure investigations and material development

By using electron microscopes, we failure and root cause analysis all new material development, component analysis and high-precision Hardness measurements.

Tokai spring's commitment is to manufactures any one-of-a-kind spring requested by our customers. "No, we cannot" is not our solution to customers.


Strict preferences for materials

Our strict quality standards begin with material selection.

If cracks or other defects occur in the steel material, it would lead to product failure in a worst case scenario. We have our own material quality standard to prevent such product failure. We have added our own composition criteria on top of the Japan Industrial Standard, "JIS" specifying material components with even higher quality and fewer impurities. We also have a specification agreements with our suppliers so that our strict composition criteria is always met.

Skilled craftsmanship and tools

The craftsman's commitment to excel and surpass is our DNA.

The final quality of a manufactured spring depends on the craftsmanship of the workers. In our company, the "craftsman's DNA" has been passed down from one generation to the next. This includes an eye for identifying the particular properties of materials, the skills to meet specifications as requested, and the ingenuity to improve tools to achieve an even higher level of quality standard.

"YU-KI "

A super coiling machine that can wind material to a diameter of Φ90 mm.

The super coiling machine, "YU-KI" applies the masterful handiwork of our craftsmen to replicate their unmatched skills. The process it uses to coil springs, by very precisely winding heated steel around a core bar with an angle appropriate to the desired size, reproduces the Master craftsman's technique.

Spring Inspections

All springs are inspected before delivery to customers.

Each spring undergoes thorough rigorous inspection phases focusing on its external appearance, dimensions, and load capacity according to our own strict product standard to assure their complete reliability at applications.

Many other types of inspections are available!

Ex) Hardness measurement, Non-destructive inspections [Magnetic particle inspection/ Liquid penetrant inspection] and Torque tests.

Spring inspection system

An internal inspection check for any product anomalies in springs to assure that products keep functioning according to their original requirements for many years to come.

- Product reception
- Receiving inspection
- Spring property testing and non- destructive inspection
- Check for abnormalities
- Report preparation
- Delivery

Hardness measurement

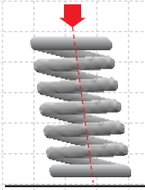
Non destructive inspection

Thrust displacement measuring and testing device

We have developed and patented an original testing device to measure the thrust, that allows us to control displacement.

Non thrust control

Load



Thrust is generated under an applied load.

With thrust control

Load

Amount of thrust displacement generated under an applied load can be minimized.

We make the springs that support our world.