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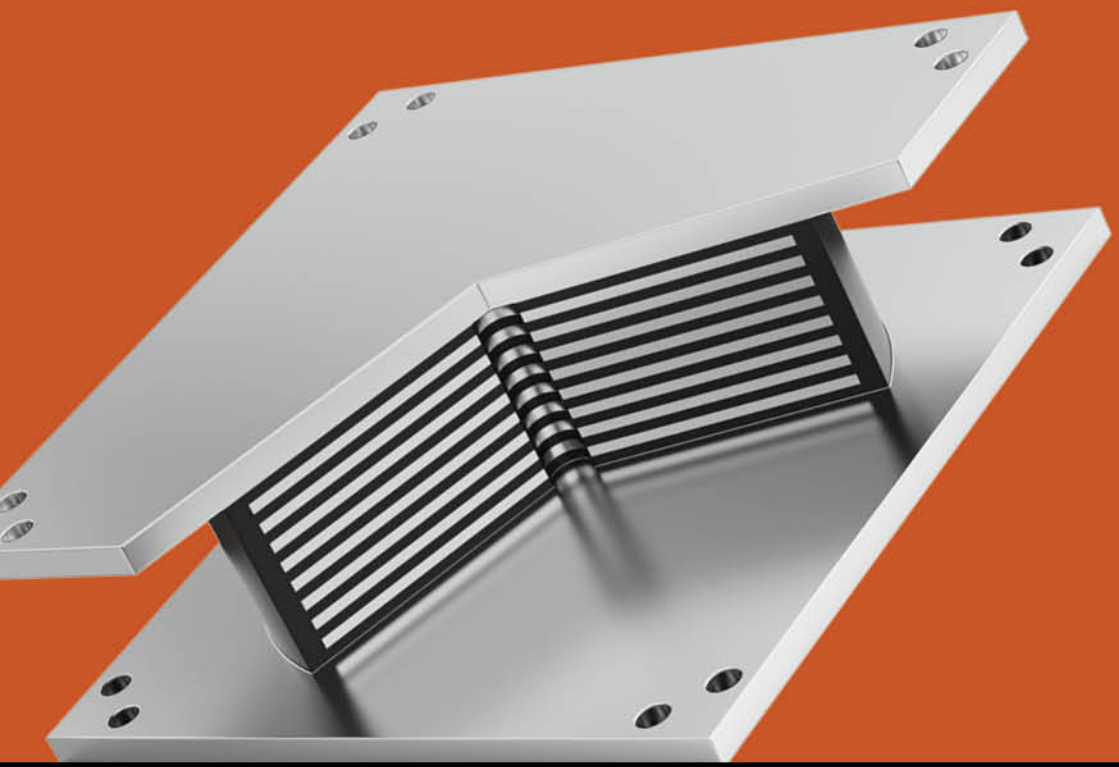
Seismic Isolation



Damping and Isolation Device For Buildings

www.tiantiebuilding.com

Company Introduction

Tiantie Group is a Chinese company, specializing in research, development, and application of seismic isolation and vibration reduction technologies in the construction industry. The company has a market cap of $600 million (USD), and is listed on the Shenzhen Stock Exchange (share code 300587).

Key facts

New Manufacturing Facility in Tiantai County

Founded

2003

Revenue

$270 Mio USD, 2021

Employees

940 (Group)

Competences

Noise and Vibration Control, Rubber Technology

Industries

Railway, Buildings, Industry

Headquarters

Tiantai, Zhejiang, China

Affiliates

20

Mission

To develop and manufacture application specific high-performance noise and vibration control technology and rubber products, for rail level crossings and industrial applications, and ensuring the highest product quality.

Vision

To be a global technology leader in vibration mitigation, with innovative products for transportation and industrial sectors and to successfully enter the seismic control market.

ZhejangTiantie Science & Technology

products stand for effectiveness, reliability, and long service life.

Milestones

2003 Tiantie established – the first Chinese company specializing in rubber products for rail track applications.

2004 Tiantie introduces the first rubber panels for level crossings. Today, we are an industry leader.

2009 Introduction of rubber-based track vibration control technology, and first installation at Chengdu-Dujiangyan Railway line.

2010 With the launch of new product lines and commissioning into service, Tiantie expands its leadership position with engineering and manufacturing of anti-vibration products for rail tracks

2013 Introduction and launch of rail dampers - with first installation at Changchun Metro line.

2016 Launch and installation of new rubber spring FST at Shenzhen Metro.

2017 Tiantie is listed at the Shenzhen Stock Exchange GEM.

2018 A total of 400km of rubber track mats installed to date.

2019 Tiantie's IPO factory started its production. The net profit was 100 million yuan for the first time.

2021 The main products have a market share of about 20% in the entire rail transit vibration and noise mitigation market, making Tiantie to the leading company in the domestic rail transit N&V mitigation field.

Introduction

Earthquakes are sudden release of energy in the form of seismic waves generated by rapid rupture of the Earth's interior layers, causing ground movements/ vibrations within a certain range. Throughout the history, destructive earthquake has always been the leading cause of disasters in structures. For this reason, isolation technologies including seismic bearings have been widely used over the past few decades and showed a significant effectiveness during numerous earthquakes.

Seismic isolations are crucial components of structure. They have now become an established and accepted technology all over the world especially for sensitive buildings including hospitals or emergency facilities which need to give a full service after an earthquake.

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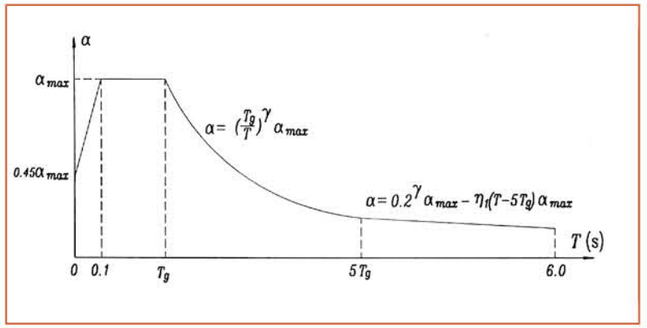
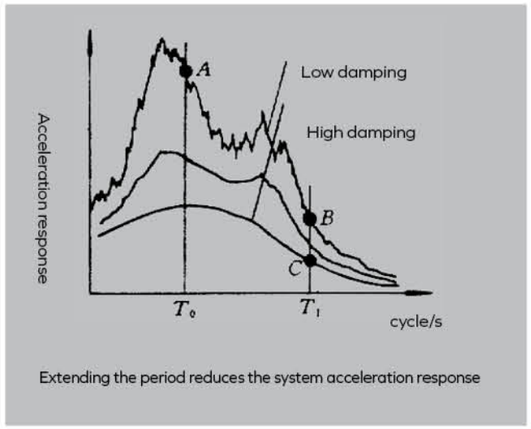
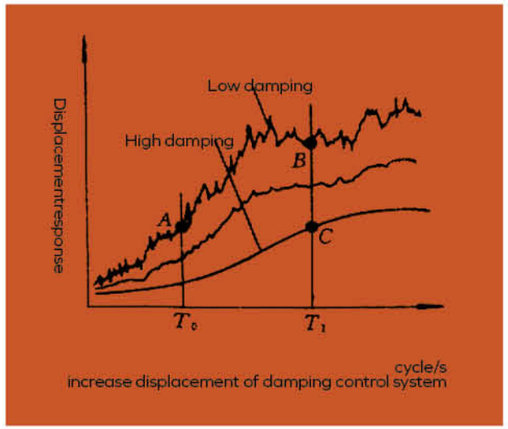


Prolong the natural vibration period of the structure

"Isolation" can extend the structural period by more than 2 times. According to the response spectrum, the seismic impact coefficient decreases with the extension of the period.

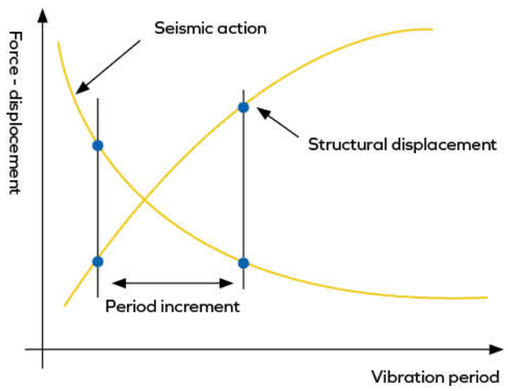


Extending the period reduces the system acceleration response



increase displacement of damping control system

Increase structural damping



The change rule of force and displacement with the period of natural vibration

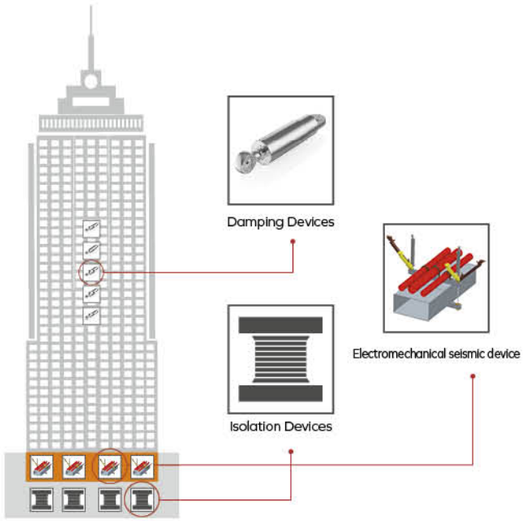
Seismic isolation products have been part of Tiantie's product offering since 2019. The company is a recognized industry leader and has received numerous patent awards for product innovation. Tiantie seismic bearings are well-suited for all common buildings and are proven to perform reliably over a very long service life.

Tiantie recommends the most suitable products according to the specific needs of customers. The products can be tailor-made and formulated with a specific design plan and supporting technical service plan according to the specific requirements of the project.

Tiantie's seismic isolation products meet the highest requirements of national, industry and local standards, and reach the international advanced level and have a high production efficiency and short lead time.

Building bearings

Principles



Seismic bearings limit the horizontal displacement and decrease the transferring seismic energy from the ground to the structure to a minimum amount at the time of high intensity earthquake occurrence by causing the structure to moves virtually as a rigid body on the isolators and the bearing accommodate large deformations at the interface by decoupling the structure from its foundation to reduce the seismic impact.

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The vibration energy generated by earthquakes is absorbed by the isolation damper

Attenuate seismic response by 20%-30%

Attenuate seismic response by 50%-80%

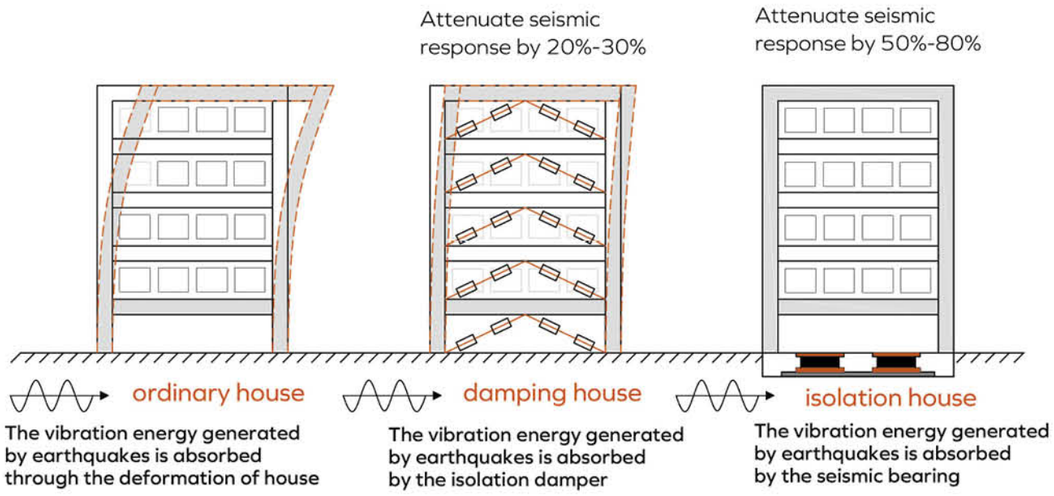
The vibration energy generated by earthquakes is absorbed by the seismic bearing

Shock-absorbing Technology

Adding devices with energy dissipation function in the superstructure can improve the damping ratio of the superstructure of the building, and the vibration reduction effect can reach 20% ~ 30%.

Seismic IsolationTechnology

Seismic isolation bearings as a layer of flexible system are set between the superstructure and foundation of the building to change the vibration characteristics of the building structure (prolong the natural frequency of the structure). During an earthquake, the deformation of the flexible system converts the horizontal shaking of the upper structure into horizontal displacement of the flexible system, isolating and dissipating most of seismic energy transmitted to the upper building structure, thereby greatly improving the earthquake resistance of the building (the isolation effect can reach 50%-80%).



The vibration energy generated by earthquakes is absorbed through the deformation of house

The vibration energy generated by earthquakes is absorbed by the isolation damper

The vibration energy generated by earthquakes is absorbed by the seismic bearing

Applications

Elastomeric Isolation Rubber Bearing:

Seismic isolation bearing decouples the structure from its foundation during an earthquake by demonstrating high stiffness performance in vertical direction and softness in horizontal direction (shear and deformation and damping)

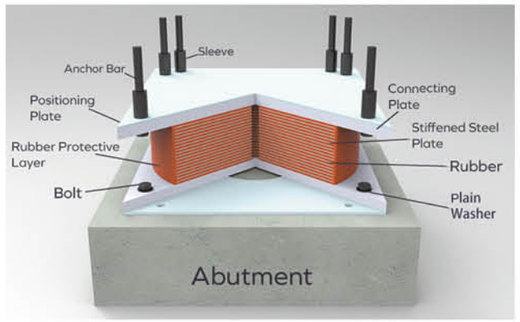
Application: widely used in the seismic isolation design and seismic reinforcement of bridges, buildings, hydropower projects and other civil structures.

Natural Rubber Bearing Type II (LNR- II)

Made of multilayer natural rubber and multilayer steel plates alternately, with good vertical bearing capacity and horizontal deformation capacity. (The support and connecting plate are vulcanized as a whole)

Features:

- The support is processed as a whole, more reliable connection;
- Excellent performance; Longer service life.



Natural Rubber Bearing (LNR)

Natural Rubber Bearing Type II (LNR-II) Serialization Parameter Table

Specifications (diameter, mm)	/	D400	D500	D600	D700	D800	D900	D1000	D1100	D1200	D1300	D1400	D1500	D1600
Shear modulus G	Mpa	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Total height of bearing H	mm	178	201	223	267	302	353	390	435	462	490	501	501	501
Total thickness of rubber layer Tr	mm	74	93	111	129	147	166	184	202	221	240	240	240	240
First form factor S1	/	≥15	≥15	≥15	≥15	≥15	≥15	≥15	≥15	≥15	≥15	≥15	≥15	≥15
Second form factor S2	/	≥5	≥5	≥5	≥5	≥5	≥5	≥5	≥5	≥5	≥5	≥5	≥5	≥5
Vertical compression stiffness Kv	kN/mm	1300	1700	1900	2400	2900	3600	4400	5300	6000	6800	8300	10000	11900
Horizontal equivalent stiffness (Shear strain 100%) Keq	kN/mm	0.68	0.84	1.02	1.19	1.36	1.53	1.70	1.88	2.05	2.21	2.56	2.94	3.34

High Damping Rubber Bearing Type II (HDR-II)

The laminated composite rubber isolation bearing with high damping performance is made by adding various ingredients in the natural rubber. The high damping rubber bearing not only maintains the good mechanical properties of the natural rubber bearing, but also has a high damping ratio, which can effectively absorb the seismic energy in the earthquake and reduce the impact of the earthquake.

Features:

- Environmentally friendly, lead-free

High Damping Rubber Bearing Type II (HDR-II) Serialization Parameter Table

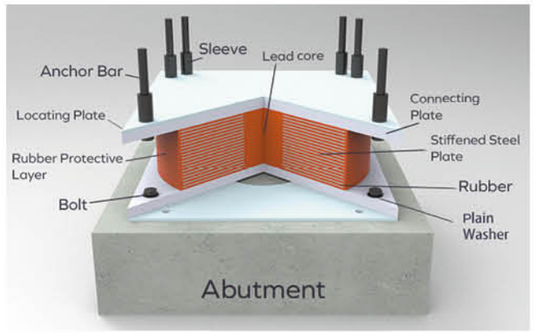
Specifications (diameter, mm)	/	D400	D500	D600	D700	D800	D900	D1000
Shear modulus G	Mpa	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Total height of bearing H	mm	178	201	223	267	302	353	390
Total thickness of rubber layer Tr	mm	74	93	111	129	147	166	184
First form factor S1	/	≥15	≥15	≥15	≥15	≥15	≥15	≥15
Second form factor S2	/	≥5	≥5	≥5	≥5	≥5	≥5	≥5
Vertical compression stiffness Kv	kN/mm	1350	1750	1950	2450	2950	3650	4450
Horizontal equivalent stiffness (Shear strain 100%) Keq	kN/mm	0.98	1.22	1.49	1.73	1.98	2.24	2.48
Yield force Q	kN	23	36	53	73	95	120	149
Stiffness after yield Kd	kN/mm	0.68	0.84	1.02	1.19	1.36	1.53	1.70
Stiffness before yield Ki	kN/mm	8.10	10.10	12.20	14.30	16.30	18.30	20.40
Equivalent damping ratio heq	/	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%

Lead Rubber Bearing Type II (LRB- II)

Made of multi-layer natural rubber and multi-layer steel plate alternately laminated and vulcanized, and the vertical lead core is embedded inside, which has good vertical bearing capacity and horizontal deformation capacity, and the lead core can absorb earthquake energy when plastic deformation occurs, greatly increase energy consumption and wind resistance of earthquake-isolated buildings. (The support and the connecting plate are integrally vulcanized).

Features:

- he bearing is processed as a whole, and the connection is more reliable;
- The performance is excellent; Longer service life;
- Strong ability to consume earthquake energy



Lead Rubber Bearing (LRB)

Lead Rubber Bearing Type II (LRB-II) Serialization Parameter Table

Specifications (diameter, mm)	/	D400	D500	D600	D700	D800	D900	D1000	D1100	D1200	D1300	D1400	D1500	D1600
Shear modulus G	Mpa	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Total height of bearing H	mm	178	201	223	267	302	353	390	435	462	490	501	501	501
Total thickness of rubber layer Tr	mm	74	93	111	129	147	166	184	202	221	240	240	240	240
First form factor S1	/	≥15	≥15	≥15	≥15	≥15	≥15	≥15	≥15	≥15	≥15	≥15	≥15	≥15
Second form factor S2	/	≥5	≥5	≥5	≥5	≥5	≥5	≥5	≥5	≥5	≥5	≥5	≥5	≥5
Vertical compression stiffness Kv	kN/mm	1400	1800	2100	2600	3100	3800	4700	5500	6200	7100	8600	10400	12300
Horizontal equivalent stiffness (Shear strain 100%) Keq	kN/mm	0.68	0.84	1.02	1.19	1.36	1.53	1.70	1.88	2.05	2.21	2.56	2.94	3.34
Yield force Q	kN	1.04	1.27	1.58	1.89	2.08	2.37	2.69	3.00	3.18	3.47	4.06	4.70	5.11
Stiffness after yield Kd	kN/mm	27	40	63	90	106	141	182	227	251	304	362	425	425
Stiffness before yield Ki	kN/mm	0.68	0.84	1.02	1.19	1.36	1.53	1.70	1.87	2.04	2.20	2.55	2.93	3.34
Equivalent damping ratio heq	/	23.5%	22.6%	24.0%	24.7%	23.1%	23.9%	24.6%	25.1%	23.9%	24.4%	24.8%	25.2%	23.2%

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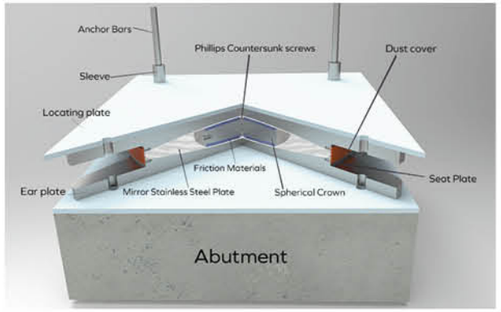
Application: Widely used in seismic design of high-rise buildings, seismic reinforcement and transformation, aerospace, machinery, industrial pipeline equipment, bridges, military and other fields

Features:

- Self-reset after earthquake;
- the vibration period is independent of the loaded mass.

Friction Pendulum System (FPS)

It is composed of steel and friction materials. The natural vibration period of the upper structure is extended by the relative sliding of the spherical sliding surface. The appropriate radius of curvature of the sliding surface is selected according to the required natural vibration period. The damping coefficient is controlled by the friction coefficient; The sliding limit bolt is set to ensure the stability of the building in non-earthquake, and easy to cut in earthquake to ensure the deformation capacity.



Friction pendulum System (FPS)

Building Friction Pendulum Support (FPS) Serialization Parameter Table

Support specification	Vertical bearing capacity	Support height	Vertical compression stiffness	Friction coefficient (slow) 0.02		Friction coefficient (fast) 0.05	
				Stiffness before yield	Equivalent stiffness	Stiffness before yield	Equivalent stiffness
FPS II-Vertical bearing capacity (kN)-Ultimate displacement (mm)-Swing period (s)		Hb	Kv	Kp	Keff	Kp	Keff
	kN	mm	kN/mm	N/mm	N/mm	N/mm	N/mm
FPS II-1000-250-3.81	1000	105	667	8000	566	20000	998
FPS II-2000-250-3.81	2000	125	1333	16000	1132	40000	1996
FPS II-3000-250-3.81	3000	140	2000	24000	1697	60000	2993
FPS II-4000-250-3.81	4000	155	2667	32000	2263	80000	3991
FPS II-5000-250-3.81	5000	170	3333	40000	2829	100000	4989
FPS II-6000-250-3.81	6000	185	4000	48000	3395	120000	5987
FPS II-7000-250-3.81	7000	200	4667	56000	3960	140000	6984

Elastic Sliding Bearing and Friction Pendulum System

Sliding Isolators decouple structures from seismic excitation with movement at their sliding surface resulting in small base shear

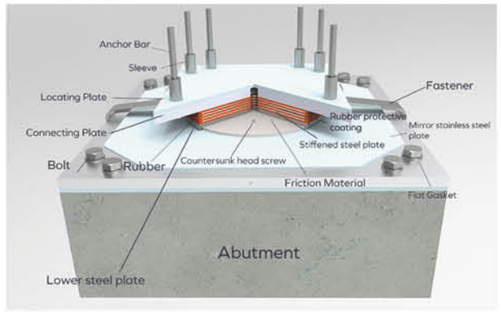
Application: mainly used in seismic isolation design and seismic reinforcement of buildings, bridges and other civil structures.

Elastic Sliding Bearing (ESB)

The sliding bearing is composed of rubber bearing, sliding material, sliding panel and upper and lower connecting plates. The bearing has sufficient vertical compressive rigidity and bearing capacity; After the bearing starts to slide, the horizontal force of the bearing is only related to the friction coefficient and vertical pressure of the sliding contact surface.

Features:

- Strong vertical bearing capacity;
- Low friction coefficient;
- The horizontal displacement is not limited by the rubber material.



Elastic Sliding Bearing(ESB)

Shock Absorption Products

Shock-absorbing products are capable to dissipate some of the energy transmitted to the upperstructure, increase damping ratio, and reduce structural damage.

Viscous Fluid Damper (VFD)

A damping (vibration) device composed of high-strength metal cylinder, piston, guide rod, sealing element and viscous damping fluid. When the cylinder and piston move mutually, the damping force generated by the movement of the built-in viscous damping fluid can absorb the impact energy of the earthquake on the building structure to the maximum extent, and mitigate the impact and damage of the earthquake on the building structure.

Features:

- Good reliability;
- strong resistance to extreme impact;
- installation, maintenance and replacement are simple and convenient.

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Buckling Restrained Brace

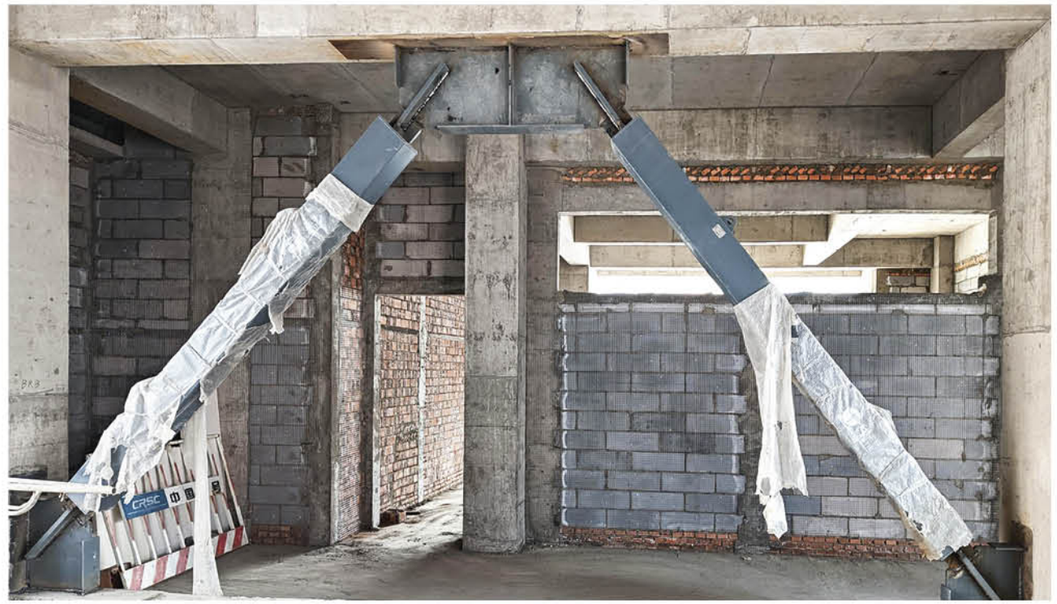
BRB buckling restrained brace is a metal tension and compression type energy dissipation and shock absorption device. It can bear axial force of full load surface yielding whether under tension or compression. Compared with traditional support components, it has more stable mechanical properties. Under compression, it shows the same hysteresis performance and excellent energy dissipation capacity. This characteristic makes it have dual structural functions, which can not only provide necessary lateral stiffness, but also add damping to the structure to reduce the vibration response of the structure under rare earthquakes.

Features:

- Bearing and energy dissipation are taken into account at the same time;
- Adjustable stiffness;
- Minimized appearance and flexible layout;
- Good ductility and hysteresis performance;
- Bearing capacity is not limited by rod length;
- The service life is the same as the design service life of the building.

Application:

Mainly used for new construction projects such as schools, hospitals, large public buildings, public places with high traffic density, industrial plants, parking lots, bridges, municipal engineering, power towers, boiler brackets, etc., as well as seismic reinforcement and renovation of existing buildings.



Windproof Device

The wind-resistant device is a wind-resistant device composed of connecting parts and partially weakened metal columns. It is mainly used in seismic isolation buildings when the rubber seismic isolation bearings cannot meet the basic wind load. In the case of medium and large earthquakes, the device is automatically destroyed without affecting the overall seismic performance of the seismic isolation building.

Features:

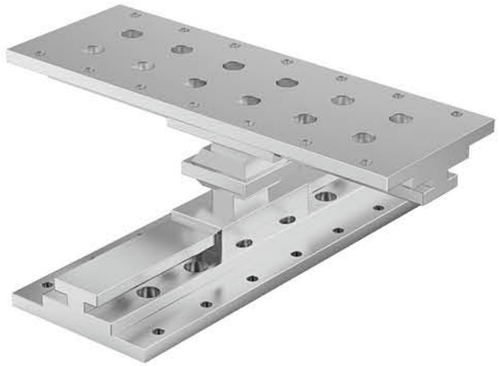
- The material is easy to obtain;
- Easy to install.

Application:

It is mainly used in seismic isolation buildings with relatively large basic wind pressure.

Tensile Device

The tensile device is mainly composed of a slide rail, a slider, a rubber pad and connecting parts to form a tensile device. The slider can slide freely on the slide rail to provide horizontal freedom, and the slider is tightly buckled on the slide rail to resist the upward pull. It is used together with the rubber isolation bearing in the seismic isolation building to share the vertical tensile stress generated by the rubber isolation bearing due to the earthquake, and improve the anti-overturning performance of the seismic isolation building.



Application:

Mainly used in seismic isolation buildings.

Features:

- Low friction;
- 360° sliding;
- Strong controllability of design displacement;
- Easy to install.

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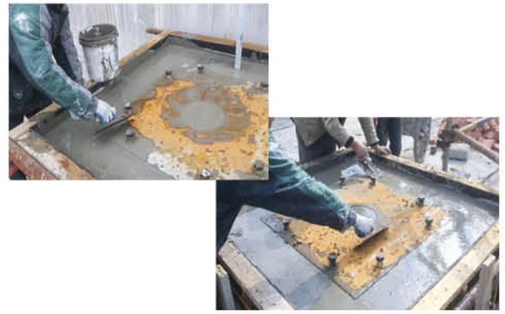
Installation procedure

Lower buttress steel bar binding

Installation of positioning plate and lower embedded components

Lower pier formwork support protection



Concrete pouring

Grinding and leveling the top surface of the lower pier

Support positioning installation

Installation of pre install compnents

Engineering Service

To ensure optimal product performance, Tiantie uses specialized computer and predictive modeling software during the design process. In addition to Tiantie's seismic bearing products, the company also provides expert installation services and/or supervision. Experienced engineers are available for installation and commissioning of all our products, including on-site monitoring and adjustments, installation reports confirming "as-built" characteristics can also be provided.

Product Testing

Product and performance testing is carried out at our in-house test lab. This allows for fast turn-around and quick response to customers. To keep pace with technical requirements and latest industry trends and innovations, Tiantie's lab and test facilities are continuously expanded with new equipment and processes.

Innovation and product development are the essence of Tiantie's corporate philosophy. Engineering experts are actively participating in national and international committees. Tiantie's commitment to innovation, along with close collaboration with universities, consulting firms and customers, provide a solid basis for the development of next generation state-of-the-art products. Continuously changing market conditions, evolving technology and new technical requirements demand timely responses and action. Tiantie's extensive in-house laboratories and testing facilities are well equipped to perform application testing or performance verification testing quickly and effectively.

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China National Accreditation Service for Conformity Assessment

LABORATORY ACCREDITATION CERTIFICATE

(Registration No. CNAS L12338)

Inspection Center of Zhejiang Tiantie Industry Co., Ltd.

(Legal Entity: Zhejiang Tiantie Industry Co., Ltd.)

No.928, Renmin East Road, Tiantai, Zhejiang, China

is accredited in accordance with ISO/IEC 17025: 2005 General Requirements for the Competence of Testing and Calibration Laboratories(CNAS-CL01 Accreditation Criteria for the Competence of Testing and Calibration Laboratories) for the competence to undertake the service described in the schedule attached to this certificate.

The scope of accreditation is detailed in the attached schedule bearing the same registration number as above. The schedule forms an integral part of this certificate.

Effective Date: 2019-06-14

Expiry Date: 2025-06-13

Signed on behalf of China National Accreditation Service for Conformity Assessment

China National Accreditation Service for Conformity Assessment(CNAS) is authorized by Certification and Accreditation Administration of the People's Republic of China (CNCA) to operate the national accreditation schemes for conformity assessment. CNAS is a signatory of the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement (ILAC MRA) and the Asia Pacific Laboratory Accreditation Cooperation Mutual Recognition Arrangement (APLAC MRA).

The validity of the certificate can be checked on CNAS website at http://www.cnas.org.cn/english/findscopeofbody/index.shtml

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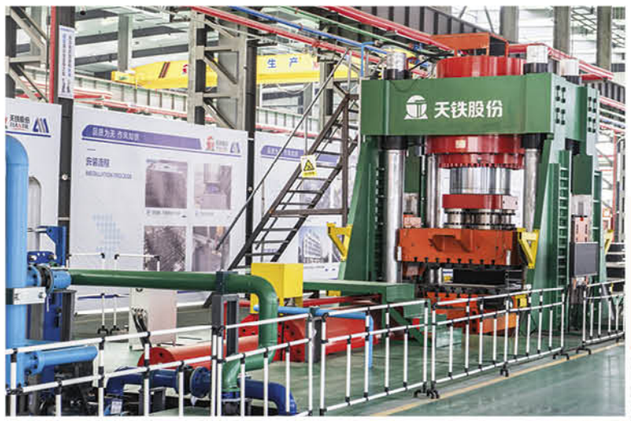
Production

Wholly-owned Zhejiang Tiantie production plants are large scale manufacturing facilities. State-of-art production equipment and processes ensure highest quality products that meet customer needs, on-time delivery, as well as regulatory requirements for environmental protection. Company production plant is equipped with sophisticated, intelligent and environmental protection large-scale production facilities. Building isolation production plant has an annual capacity of 50,000 sets.

The company takes "intelligent manufacturing and green manufacturing" as the leading factor, empowers products with ultra-high process standards, explores upgrading traditional manufacturing with Internet factories, and relies on digital system platforms such as intelligent and highly monitored, M and environmentally friendly large-scale production equipment to produce for the company High-quality products provide an important hardware foundation.

The company has a national CNAS-certified experimental center, which can provide professional and accurate testing services. The experimental center has 5000kN, 20000kN electro-hydraulic servo dynamic compression shear testing machine, 2500kN electric 3ron0 damping machine universal testing machine, dynamic and static fatigue testing machine, ozone testing machine, aging test chamber and other professional testing and R & D equipment.



Quality Control

Global markets require compliance with a variety of different standards. Tiantie's Quality Management System ensures that product and process standards are consistent, in compliance, and documented in accordance with standards. Test reports, certifications and customer testimonials are available on request.

Occupational Health and Safety System according to ISO 45001

Environmental Management system according to ISO 14001

Quality Management System according to ISO 9001

References

Over 11900 of Tiantie building isolation products have been successfully installed.

School Atushi,Xinjiang

Residential buildings, Urumqi, Xinjiang

University Training

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Selected Tiantie Seismic isolation Projects

Project	Construction area	Quantity used
Liangshan Science and Education Park and medical education service project	270,000 m²	675 sets
Changji People's Hospital New District Hospital Construction Project (Phase I)	310,000 m²	612 sets
Qujing Medical College Malone Campus construction project	310,000 m²	945 sets
Langfang Fenghua Senior High School project	65,000 m²	451 sets
Dali Midu County Fuyaju project O	33,000 m²	112 sets
Wujinshan Middle School renovation and expansion Project	78,000 m²	382 sets
Linfen City Central Hospital outpatient complex building O	240,00 m²	185 sets
CRRC Sifang Zhihui Port Phase I project - Professional and residential facilities	189,000 m²	2175m2
Nanjing G111 Project (36-9 Block in Southwest China) TOD	85,000 m²	1313m2

Zhejiang Tiantie Science & Technology Co. Ltd.

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