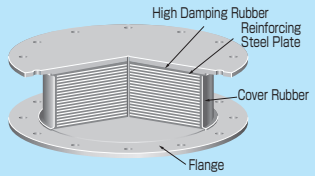
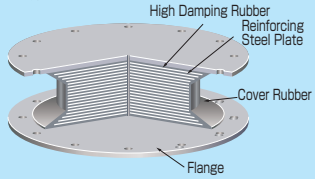
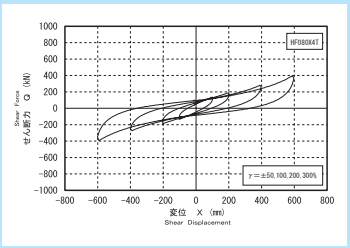
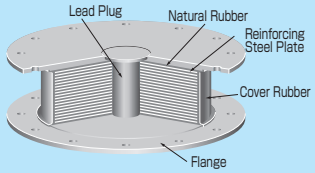
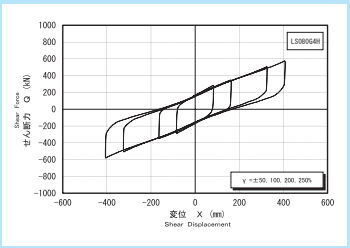
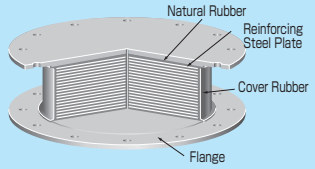
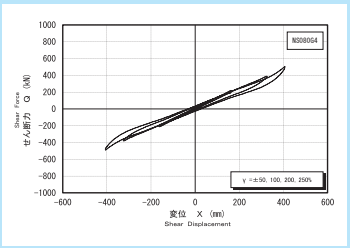
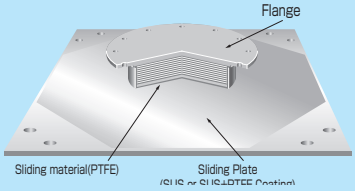
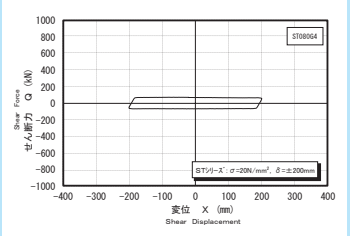
BRIDGESTONE
Solutions for your journey

BRIDGESTONE
Seismic Isolation Products for Buildings
2026 Vol.1

High Damping Rubber Bearing / Lead Rubber Bearing / Natural Rubber Bearing / Elastic Sliding Bearing



Bridgestone Seismic Isolation Product Line-up

	Features	Sectional View	Hysteresis Loop
HDR High Damping Rubber Bearing	High damping rubber bearing uses high damping rubber. The rubber material itself provides both spring and damping capability. As the bearing itself provides damping capability, a separate damper may not be required, or the number of dampers can be reduced. Since the hysteresis curve is relatively smooth, seismic isolation performance can be expected not only for the building itself but also for precision equipment and other contents inside the building. Four rubber materials with different elastic moduli are available: X0.3R, X0.4T/X0.4S and X0.6R. These series provide excellent applicability from light column loads to high-rise buildings. The new Flared Type adopted for rubber code X0.4T provides higher ultimate compressive stress than the Conventional Type. As a result, the nominal compressive stress is set higher than that of X0.4S, and the available strain range is also expanded.	Conventional Type  Flared Type 	
LRB Lead Rubber Bearing	Lead rubber bearing consists of a laminated natural rubber with a lead plug embedded at its center. The natural rubber provides the spring function, while the lead plug provides the damping function. As the bearing itself provides damping capability, a separate damper may not be required, or the number of dampers can be reduced. It exhibits elastoplastic hysteretic characteristics, and the damping level can be finely adjusted by changing the lead plug diameter. The bearing is available with rubber grade G0.40.		
NRB Natural Rubber Bearing	Natural rubber bearing provides low damping, with an equivalent damping ratio of approximately 2 to 3%, excellent linearity, and stable restoring force characteristics. A separate damper is required in combination with the bearing. However, high design flexibility can be achieved by selecting the appropriate damper type and damping level. Four rubber materials with different elastic moduli are available: G0.30, G0.35, G0.40, and G0.45, allowing the bearing to support a wide range of column loads.		
Elastic Sliding Bearing	Elastic Sliding Bearing consists of a laminated rubber body, formed by attaching PTFE-based sliding material to the bottom of a natural rubber bearing and a sliding plate mainly made of SUS material. Under small deformation, the laminated rubber body accommodates the movement. As deformation increases, sliding occurs between the sliding material and the sliding plate, allowing the bearing to follow the deformation. Since restoring capability is lost after sliding occurs, the bearing is normally used in combination with NRB, LRB, or HDR. Two low-friction types are available.		

Note: The structural diagrams and loop diagrams are for reference only and may not represent the actual product's shape or performance.

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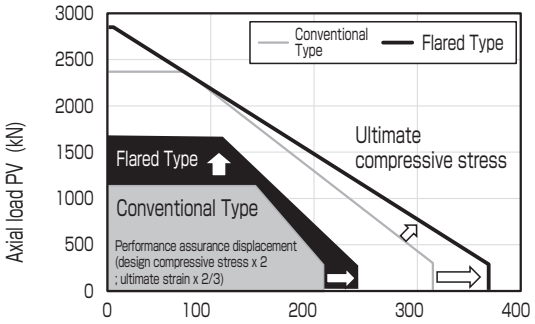
Introduction of Products & Services

1. New-profile of Laminated Rubber Bearing with Improved Ultimate Properties for Compressive Stress and Deformation

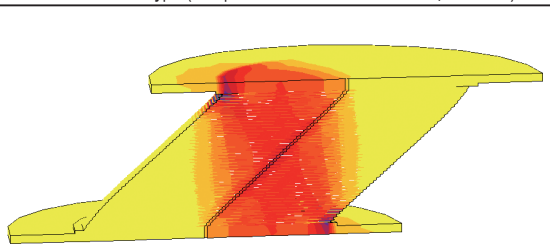
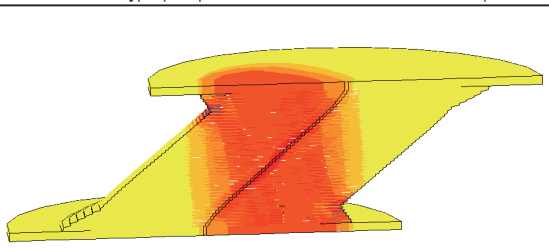
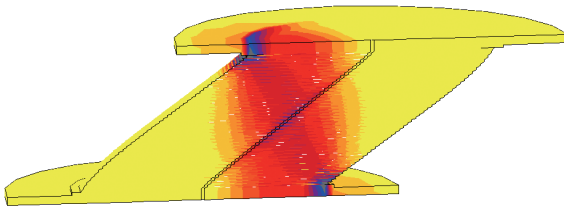
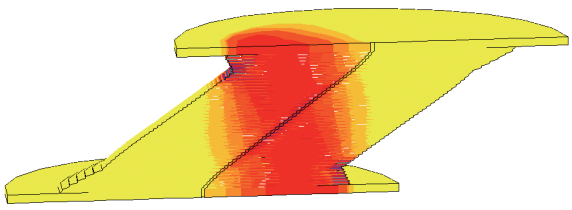
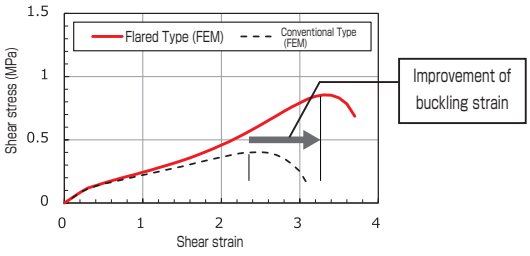
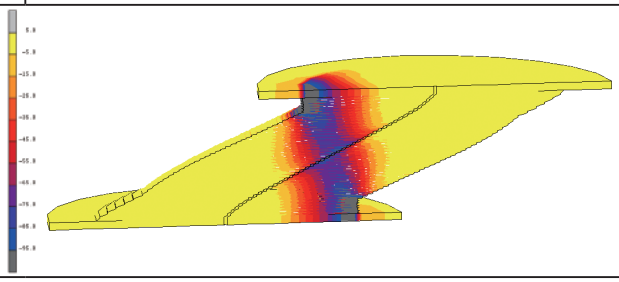
The flared type incorporates a flared profile at the upper and lower ends of the laminated rubber bearing, increasing the load-bearing area under large deformation. FEM analysis and testing have confirmed improved shear strain capacity up to buckling compared with the conventional type. For conventional type bearings, the rubber diameter sometimes had to be increased relative to the long-term axial load, depending on the relationship between response displacement in seismic response analysis and short-term compressive stress. The flared type enables more efficient design and contributes to improved seismic isolation performance.

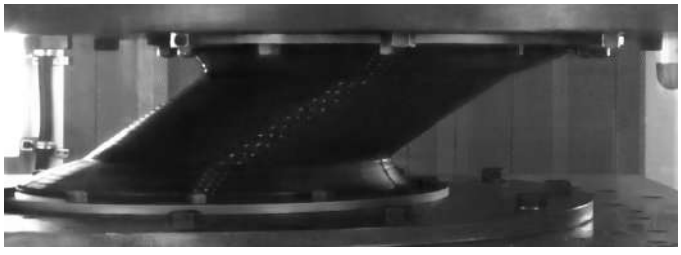
Analysis model

	Conventional Type	Flared Type
Center rubber outer diameter D_1 (mm)	350.0	342.5
Maximum rubber outer diameter D_2 (mm)	350.0	410.0
Effective outer diameter D_e (mm)	350.0	
Rubber inner diameter D_i (mm)	7.5	
Thickness of one rubber layer t_r (mm)	2.35	
Number of rubber layers	43	Lower & upper end: 5 each Center: 33
Steel plate thickness t_s (mm)	2.2	
S_1/S_2 or S_1*/S_2*	36.4/3.46	



Comparison of ultimate compressive stress

Strain	Conventional Type (compressive stress 13.6N/mm^2, 1307kN)	Flared Type (compressive stress 13.6N/mm^2, 1307kN)
200%		
240% buckling strain of conventional type		
333% buckling strain of flared type		

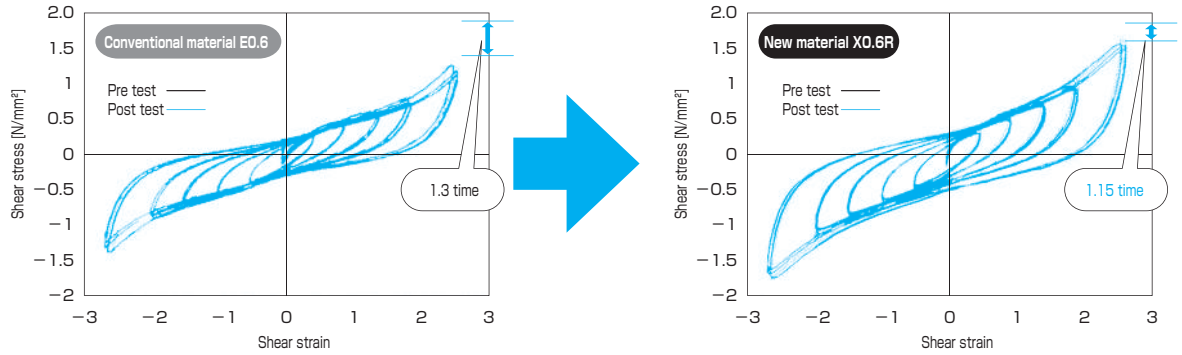

Full-scale test HF070X4T
200% shear strain ; compressive stress 9.2 N/mm^2 (3810 kN)

2. High Damping Rubber Bearing X Series

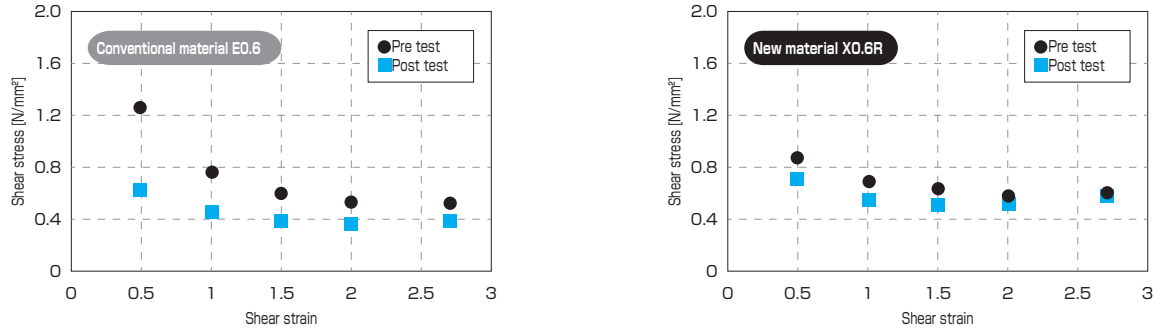
Features of High Damping Rubber Bearing X Series

High damping rubber bearing is a laminated rubber structure that includes a special filler compound in the rubber itself to provide energy absorption performance. It combines damping and spring characteristics and is widely adopted as a seismic isolation rubber bearing. However, the conventional high damping rubber shows loading hysteresis dependency, where its rate of change of stiffness has become reduced and restoration becomes progressively worse after repeated loading under increasing deformation. With Bridgestone's next-generation of high damping rubber X series, the effect of loading hysteresis dependency is greatly reduced and the properties become much simpler to manage. Furthermore, it is also more accommodating to the reduction in ultimate properties caused by bi-directional loading.

● Reduction in Loading Hysteresis Dependency



Compared to conventional high damping rubber, the change of equivalent shear stiffness (1cycle/3cycle) in repeated loading is greatly reduced. The properties of seismic isolation bearings are defined by the 3rd cycle and it is able to reduce the load variation during initial deformation.



Conventional high damping rubber shows shear stress reduction after large deformation due to the effect of loading hysteresis dependency, but the next-generation high damping rubber is able to minimize the change in properties before and after large deformation. By reducing the effect of loading hysteresis dependency, the accuracy of the overall seismic isolation design can be improved.

3. Ultimate Properties of High Damping Rubber Bearing under Horizontal Bi-directional Loading

Horizontal bi-directional loading tests confirmed that torsional deformation occurs on the rubber side surface and that rupture occurs earlier than under horizontal unidirectional loading. Based on these results, the Japan Society of Seismic Isolation (JSSI) established standard values for ultimate strain. The final ultimate strain is determined as the smaller value between γ L, the ultimate strain under horizontal unidirectional loading shown in Table 1, and γ bo, the ultimate strain under horizontal bi-directional loading shown in Table 2.

Table 1: Standard Value of Ultimate Strain under Horizontal Unidirectional Loading

Rubber Code	Ultimate Strain under Horizontal Unidirectional Loading, γ_L
X0.3R	S_2×0.9×100% (0.9×S_2<4)、400% (0.9×S_2≧4)
X0.4S	S_2×0.9×100% (0.9×S_2<4)、400% (0.9×S_2≧4)
X0.4T	γ_{oa0} × 0.9 × 100%(0.9 × γ_{oa0} < 4)、 400% (0.9 × γ_{oa0} ≧ 4)
X0.6R	S_2×0.9×100% (S_2<4.5)、400% (S_2≧4.5)

S_2 : second shape factor, D_2 : maximum rubber outer diameter, Hr : total rubber thickness
γ_{oa0} : strain at which overlap area becomes zero (For flared type, γ_{oa0}=D_2/Hr)

Table 2: Standard Value of Ultimate Strain under Horizontal Bi-directional Loading

Rubber Code	Ultimate Strain under Horizontal Bi-directional Loading, γ_{bo}
X0.3R	γ_{bo} = (5.80×S_2+7.10) / (S_2+3.45)×100%
X0.4S	γ_{bo} = (5.80×S_2+9.05) / (S_2+4.49)×100%
X0.4T	γ_{bo} = (5.80×a×S_2*+de^3×9.05) / (a×de^2×S_2*+de^3×4.49)×100%
X0.6R	γ_{bo} = (5.00×S_2+9.05) / (S_2+4.49)×100%

S_2,S_2* : second shape factor, D_1 : nominal center rubber outer diameter, D_e : effective outer diameter, T_{r1} : total rubber thickness at the center
d_e:dimensionless quantity obtained by dividing effective outer diameter by nominal center rubber outer diameter (=D_e / D_1)
a : dimensionless quantity obtained by dividing total rubber thickness by total rubber thickness at the center (=Hr / T_{r1})

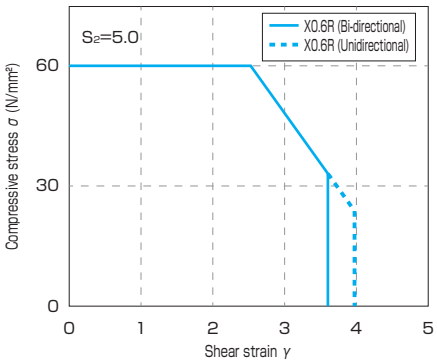


Figure 1 : Comparison Example of Ultimate Property Diagram

4. Response to Revised Notification

Following the revision to Ministry of Construction Notification No. 1446 of 2000, which came into effect on April 1, 2020, internal standards must define the necessary requirements that allow the purchaser, or a third party designated by the purchaser, to verify that the products satisfy the specified performance requirements. Bridgestone responds to these requirements as described below and appreciates customers' understanding and cooperation.

Revision	Bridgestone's Response and Requests to Customers
1.For products subject to witness inspection, the purchaser or related party designates the products.	Products subject to witness inspection or verification inspection should be clearly identified in the manufacturing and inspection procedure or the designated form. Inspections may also be conducted remotely.
2. The purchaser or related party verifies that the inspections are conducted properly in accordance with the attachment to the Ministerial Certification or the evaluation report, and that the inspection reports are prepared using primary data and other inspection data obtained at the time of inspection.	Using the witness inspection checklist attached to the manufacturing and inspection procedure, the purchaser or related party should verify that the inspection items and acceptance criteria are appropriate in accordance with the Ministerial Certification. Even when project-specific requirements differ from the certified items, the checklist indicates the judgment values specified in the Ministerial Certification. Witness inspection is conducted for the full sequence of operations, from input of inspection conditions through data analysis, under confirmation by the representative witness. For reasons of work progress and safety, entry into the operator room is limited to one representative. One representative should be designated by the witness inspection date.
3. The purchaser or related party verifies that inspection data are stored and that tamper-prevention measures are implemented in accordance with the attachment to the Ministerial Certification or evaluation report.	The storage status of inspection data, including raw data, will be verified, and the implemented tamper-prevention measures will be explained. Once the inspection data have been properly stored and approved by the person responsible for internal quality control promotion, the inspection report, including coating inspection reports, will be issued.

Bridgestone has obtained general evaluations for the listed products in accordance with the revised notification.

Table 3 : Applicable Products and Ministerial Certification / Evaluation Numbers

Product Type	Rubber Type / Series	Ministerial Certification No.	Evaluation No.
High Damping Rubber Bearing	X0.3R	MVBR-0516	BCJ Evaluation-IB8001-01
	X0.4S	MVBR-0510/MVBR-0519	
	X0.6R	MVBR-0514/MVBR-0520	
	X0.4T	MVBR-0650-1	Note: Flared Type (X0.4T) is certified for the revised notification under MVBR-0650-1.
Lead Rubber Bearing	G0.40	MVBR-0517	BCJ Evaluation-IB8003-01
Natural Rubber Bearing	G0.30,G0.35,G0.45	MVBR-0295	BCJ Evaluation-IB8002-01
	G0.40	MVBR-0509/MVBR-0518/MVBR-0540	
Elastic Sliding Bearing	ST Series	MVBR-0581	BCJ Evaluation-IB8004-01
	SK Series	MVBR-0548	

5. Response to Long-period Ground Motion

In response to the June 24, 2016 notice issued by the Ministry of Land, Infrastructure, Transport and Tourism, Japan, titled "Countermeasures for Long-Period Ground Motion Caused by a Large Earthquake along the Nankai Trough for High-Rise Buildings and Other Structures," Ministerial Certification procedures based on performance evaluation have been strengthened for newly constructed buildings over 60 m in height and seismically isolated buildings of four or more stories above ground in the applicable districts. The effect of cumulative displacement caused by long-period, long-duration ground motion must therefore be considered. For existing buildings, reinforcement and other measures are considered desirable. Bridgestone applies two response approaches depending on the seismic isolation rubber product type.

① Product types requiring consideration of repeated deformation (High Damping Rubber Bearing and Lead Rubber Bearing)
General evaluation from the Building Center of Japan has been obtained. Through this third-party evaluation, the validity of the calculation method for performance changes in seismic isolation rubber bearings under long-period ground motion, as well as the data obtained using that method, has been confirmed.

Applicable Product Name	Building Center of Japan Evaluation No.	Date Acquired
High Damping Rubber Bearing (X0.3R)	BCJ Evaluation-IB0010-02	11 March 2022
High Damping Rubber Bearing (X0.4S)		
High Damping Rubber Bearing (X0.4T)	BCJ Basic Evaluation-IB0040-02	13 September 2024
High Damping Rubber Bearing (X0.6R)	BCJ Evaluation-IB0010-02	11 March 2022
Lead Rubber Bearing	BCJ Evaluation-IB0012-02	8 April 2022

② Product types with minor repeated deformation effects (Natural Rubber Bearing and Low-friction Sliding Bearing)
Technical documents are available summarizing test results under repeated deformation with a cumulative deformation of 50 m or more.

6. Project Support by Manufacturing Process (Conventional Process / New Process)

For seismic isolation rubber bearings, Bridgestone adopts two manufacturing processes: the conventional process, referred to as the A-process, and the new process, referred to as the B-process. Since part of the overall manufacturing process differs between the two processes, separate Ministerial Certifications have been obtained. However, there is no difference in product performance, and the stated numerical performance values are exactly the same. Even within the same project, products of the same rubber diameter may include both A-process and B-process products.

Applicable products for combined A-process / B-process production are as follows.

Applicable Product Name	Applicable Shapes	Applicable Size (Rubber Diameter)	Ministerial Certification No.
High Damping Rubber Bearing (X0.4S)	HH Series HT Series HL Series HS Series	φ 600～φ 1000	MVBR-0510 (A-process) MVBR-0519 (B-process)
High Damping Rubber Bearing (X0.6R)	HH Series HT Series HL Series	φ 600～φ 1000	MVBR-0514 (A-process) MVBR-0520 (B-process)
Natural Rubber Bearing (G4)	NH Series NT Series NL Series NS Series	φ 600～φ 1000	MVBR-0509 (A-process) MVBR-0518 (B-process)

To help support delivery schedules during busy periods, Bridgestone requests that both certification numbers be indicated in the design documents.

7. Standard Values for Ultimate Tensile Strength of Natural Rubber Bearing (MVBR-0540)

When tensile load acts on a laminated rubber bearing and exceeds a certain critical point, microscopic voids are considered to occur inside the rubber. The allowable tensile stress of seismic isolation rubber bearings was conventionally limited to 1.0MPa because the mechanical properties and aging/degradation characteristics after void occurrence had not been sufficiently verified. Through testing under various conditions, Bridgestone experimentally demonstrated that subsequent properties remain acceptable even after exceeding the yield point, provided that the response remains within a certain range. Based on these results, Bridgestone established the tensile limit using both the conventional tensile stress criterion and a new tensile strain criterion and obtained Ministerial Certification.

Scope of MVBR-0540

Rubber Materials	Code	Natural Rubber G0.40
	Shear Modulus G (N/mm^2)	0.392
Rubber Diameter	Rubber Outer Diameter	ϕ 600 ~ 1800
	Rubber Inner Diameter	ϕ 15 ~ ϕ 125 *1

*1: For products with multiple inner holes, the combined cross-sectional area of the inner holes is converted to an equivalent diameter with the same total area.

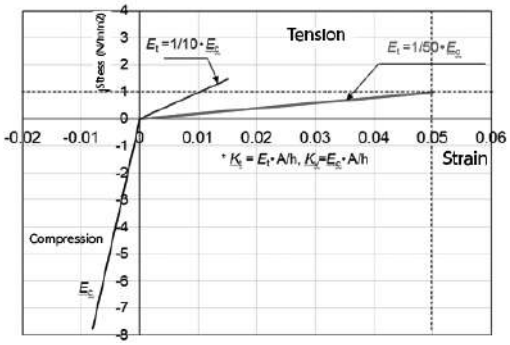
Conventional Certification Standard

	Tensile Limit Criterion	Tensile Stiffness
Ultimate Tensile Strength	$\sigma_t \leqq 1.0$ (N/mm^2)	Not specified

Standard Values for Tensile Ultimate Strength in MVBR-0540 (Choose One of the Two Criteria)

	Tensile Limit Criterion	Tensile Stiffness
① When Designing Based on Tensile Strain ε t	$\varepsilon_t \leqq 5.0\%$ and $\sigma_t \leqq 1.0$ (N/mm^2)	$K_t \leqq 1/50 \cdot K_V$
② When Designing Based on Tensile Stress σ t	$\sigma_t \leqq 1.0$ (N/mm^2)	$K_t \geqq 1/10 \cdot K_V$

K_v : Compressive Vertical Stiffness



The tensile strain criterion is applicable only to Natural Rubber Bearing G0.40. For other Natural Rubber Bearings, High Damping Rubber Bearings, and Lead Rubber Bearings, design should be based on the conventional tensile stress limitation. When MVBR-0540 is applied, either the tensile strain criterion or the tensile stress criterion should be selected within the same project.

8. Steel Materials Used for Flanges and Reinforcing Steel Plates

The steel materials used for seismic isolation rubber bearings are JIS-compliant products manufactured at JIS-certified plants in Japan or overseas and are made using either blast-furnace steel or electric-furnace steel. For details, refer to the relevant product pages for High Damping Rubber Bearings, Lead Rubber Bearings, Natural Rubber Bearings, and Elastic Sliding Bearings.

9. LAP²+t (LAP Square: Seismic Isolation Device Layout Planning Assistance Program)

LAP²+t is a program that supports layout planning for Bridgestone seismic isolation rubber bearings during the structural planning of seismically isolated buildings. The software can be downloaded free of charge from the website below after user registration.
http://www.bridgestone.co.jp/products/dp/antiseismic_rubber/download_lap2.html

Features of LAP²+t

Simple Input

Column locations, column axial loads, device selection, and superstructure information can be entered easily.
Data can also be imported from Union System's integrated structural calculation software Super Build/SS3, SS7.
* [Super Build] is a registered trademark of Union System Inc

Seismic Isolation Devices

In addition to Bridgestone seismic isolation rubber bearings, general oil dampers and hysteretic dampers can also be arranged. Device performance values do not need to be entered, and the software includes a function for automatically selecting the size after the seismic isolation rubber bearing type is selected.

Two Calculation Methods Available: Notification-Based and Time-History Analysis

・Seismic response calculation based on the Seismic Isolation Notification*1
・Seismic response calculation based on time-history analysis
Linkage with Union System Inc.'s "SuperDynamicPro" is also available after response calculation.
*1: Structural calculation method based on Ministry of Construction Notification No. 2009 of 2000, "Technical Standards Necessary for Safety Concerning Structural Methods of Seismically Isolated Buildings."

Although this software was originally provided for users who are not familiar with seismic isolation design, it is easy to use and offers a wide range of functions. As a result, it is increasingly being used by experienced seismic isolation designers as well, including for preliminary design estimates during the basic planning stage. Before using the software, please review the Terms of Service available on the download site above.

10. Various Corrections Applied to Raw Performance Inspection Data during Shipment Inspection

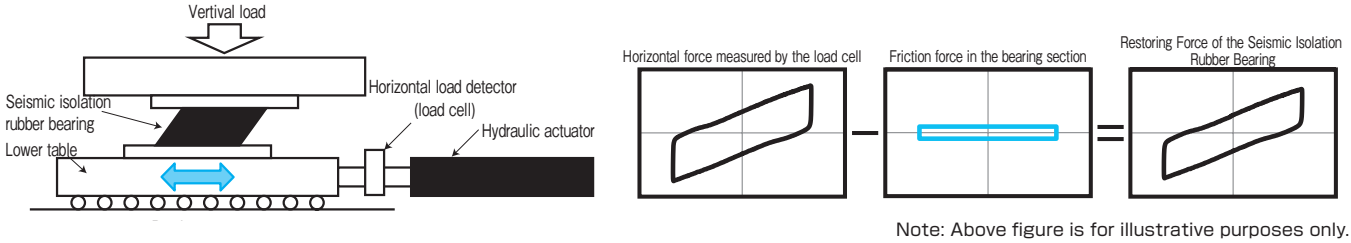
At present, all seismic isolation rubber bearings are subject to performance inspection test as part of shipment inspection. Due to the unique characteristics of seismic isolation rubber bearings, various corrections are applied to the raw performance values obtained during performance inspection test. Pass or fail judgment is then made based on the corrected values. These corrections are applied to the horizontal performance inspection test results. An overview of the corrections is shown below.

1) Corrections Due to Inspection Conditions

① Temperature Correction	The performance values of rubber products vary depending on the product temperature. Therefore, the values are corrected to the performance values at the standard temperature of 20° C.
② Speed / Frequency Correction	For High Damping Rubber Bearings, Lead Rubber Bearings, and Elastic Sliding Bearings, performance values vary depending on the speed at which deformation is applied during inspection test. Domestic test machines for seismic isolation rubber bearings cannot perform dynamic loading due to test machine capacity limitations. Therefore, inspection is performed under static loading, and the results are corrected to dynamic performance values.

2) Correction Due to Test Machine Structure

③ Test Machine Friction Correction	This correction is required due to the structure of the seismic isolation rubber bearing test machine. During inspection, the measuring instruments of the test machine measure not only the performance of the seismic isolation rubber bearing, but also the friction force of the bearings inside the roller guide of the test machine. This correction removes the friction force of the bearings inside the roller guide and extracts only the performance values of the seismic isolation rubber bearing. (Refer to the figure below)

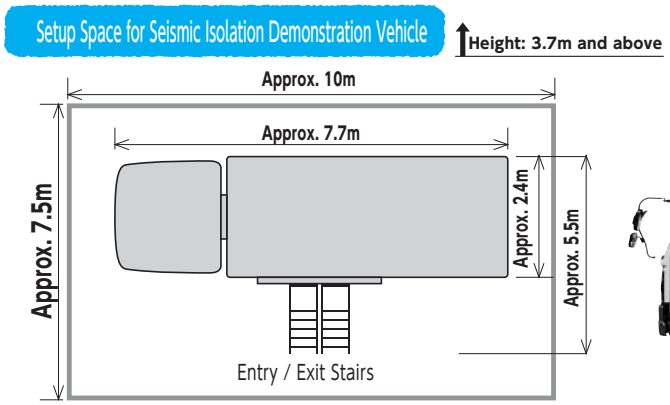


Note: Above figure is for illustrative purposes only.

For ① Temperature Correction and ② Speed Correction, the correction methods are specified in the Ministerial Certification and the manufacturing and inspection procedure, and each correction value can be confirmed in the shipment inspection reports submitted to customers. For ③ Test Machine Friction Correction, the correction method is strictly controlled in accordance with the work procedures established by Bridgestone's quality assurance department, and the test machine friction coefficient is indicated in the shipment inspection report.

11. Seismic Isolation Demonstration Vehicle

To help more people understand the effectiveness of the seismic isolation technology, Bridgestone has prepared a Seismic Isolation Demonstration Vehicle that allows users anywhere in Japan to experience the difference in shaking during an earthquake between a seismically isolated building and a typical earthquake-resistant building.
※ If you would like to use the Seismic Isolation Demonstration Vehicle, please contact the address listed on the back cover of this catalogue in advance.



For safety, a clearance of approximately 1m is required around the demonstration vehicle.



(Example setup of the seismic isolation demonstration vehicle)

Available Nationwide

By utilizing the Bridgestone Group network, demonstrations are available in all areas of Japan.
(Costs will be discussed separately)

Easy-to-Understand Seismic Isolation Demonstrations

At the dispatch location, presentations can also be provided using the onboard large-screen LCD TV and PC.
(Audio equipment is included)

Serve as an Information Hub in Emergencies

The vehicle is equipped with a 15 kVA engine generator and a terrestrial digital TV receiving antenna. In emergencies, the vehicle can be used as an information hub.

Environmentally Friendly

The vehicle is fitted with Bridgestone's low-fuel-consumption ECOPIA tires, supporting both safety and environmental and economic performance.

12. Seismic Isolation Museum

At the Seismic Isolation Museum located inside Bridgestone's Yokohama Plant, visitors can learn the fundamentals of seismic isolation rubber bearings, Bridgestone's proprietary technologies, the manufacturing process of seismic isolation rubber bearings, and the history of seismic isolation. The Seismic Isolation Demonstration Simulator allows visitors to experience the difference in shaking between a seismically isolated building and a typical earthquake-resistant building. The museum is designed to help building owners who are considering seismic isolation gain a clear understanding of seismic isolation systems and seismic isolation rubber bearings. The presentation room is also used for technical seminars for designers and contractors, as well as factory tours.

※ If you would like to use the Seismic Isolation Museum, please contact the address listed on the back cover of this catalogue in advance.



Seismic Isolation Demonstration Simulator



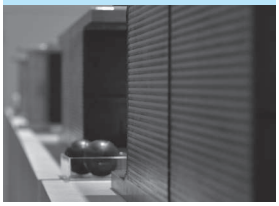
History of Seismic Isolation



Technology of Seismic Isolation Rubber Bearings



Types of Seismic Isolation Rubber Bearings



Installation Examples of Seismic Isolation Rubber Bearings



13. Seismic Isolation Web

To help customers learn more about Bridgestone seismic isolation rubber bearings, Bridgestone has launched the dedicated "Menshin Web" site. The site explains how seismically isolated buildings and seismic isolation rubber bearings work, and presents customer testimonials from projects using Bridgestone seismic isolation rubber bearings, together with supporting documents and videos.

Menshin Web



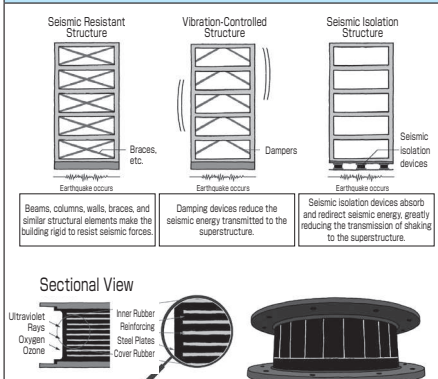
Dedicated Site for
Bridgestone Seismic Isolation Rubber Bearings

A variety of content is available to help users learn more about the knowledge and benefits of seismic isolation rubber bearings. Site banners for linking are also available. Please feel free to contact Bridgestone for more information.

Bridgestone Menshin Web Search

URL: https://www.bridgestone.co.jp/sc/menshin-web/

Seismic Resistant Structure



Explains how seismically isolated buildings and seismic isolation rubber bearings work

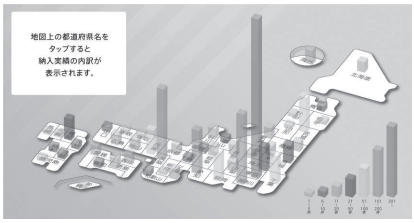
Customer Testimonials





Customer testimonials from projects using Bridgestone seismic isolation rubber bearings are presented by building application.

Project References and Document Downloads



Project references and achievements by prefecture are available, along with various brochures for download.



14. Information on Downloading CAD Data and Technical Documents for Seismic Isolation Rubber Bearings

CAD data (DXF) and technical documents for Bridgestone seismic isolation rubber bearings for building applications are available for free download from the website after user registration. Before registering and downloading the materials, please review the [Terms of Service and the Handling of Personal Information].

https://www.bridgestone.co.jp/products/dp/antiseismic_rubber/download_cad.html

[Note]
* Registered users are responsible for managing their own ID and password.

15. Lead Plug Diameter List

For Lead Rubber Bearings, the suffix code at the end of the product designation indicates the lead plug diameter. The table below shows the corresponding lead plug diameter for each code.

LH Series (Total Rubber Thickness 20cm)

Outer diameter of rubber bearing, Do(mm) / Lead plug diameter, Dp(mm)	600	650	700	750	800	850	900	950	1000	1100	1200	1300	1400	1500
370														M
360														L
350														K
340													L	J
330													K	I
320												L	J	H
310												K	I	G
300											L	J	H	A
290											K	I	G	B
280											J	H	A	C
270										K	I	G	B	D
260										J	H	A	C	E
250									K	I	G	B	D	F
240								K	J	H	A	C	E	S
230							K	J	I	G	B	D	F	T
220						K	J	I	H	A	C	E	S	
210						J	I	H	G	B	D	F	T	
200					J	I	H	G	A	C	E	S		
190				J	I	H	G	A	B	D	F			
180			J	I	H	G	A	B	C	E	S			
170		J	I	H	G	A	B	C	D	F				
160	J	I	H	G	A	B	C	D	E					
150	I	H	G	A	B	C	D	E	F					
140	H	G	A	B	C	D	E	F						
130	G	A	B	C	D	E	F							
120	A	B	C	D	E	F								
110	B	C	D	E										
100	C	D	E											
90	D	E												
80	E													

LT Series (Total Rubber Thickness 25cm)

Outer diameter of rubber bearing, Do(mm) / Lead plug diameter, Dp(mm)	900	950	1000	1100	1200	1300	1400	1500	1600
390									M
380									L
370								M	K
360								L	J
350								K	I
340							L	J	H
330							K	I	G
320						L	J	H	A
310						K	I	G	B
300					L	J	H	A	C
290					K	I	G	B	D
280					J	H	A	C	E
270				K	I	G	B	D	F
260				J	H	A	C	E	S
250			K	I	G	B	D	F	T
240		K	J	H	A	C	E	S	
230	K	J	I	G	B	D	F	T	
220	J	I	H	A	C	E	S		
210	I	H	G	B	D	F	T		
200	H	G	A	C	E	S			
190	G	A	B	D	F				
180	A	B	C	E	S				
170	B	C	D	F					
160	C	D	E						
150	D	E	F						
140	E	F							
130	F								

LD Series (Total Rubber Thickness 32cm)

Outer diameter of rubber bearing, Do(mm) / Lead plug diameter, Dp(mm)	1600	1700	1800
215 × 4			M
210 × 4			L
205 × 4			K
200 × 4		L	J
390	M	K	I
380	L	J	H
370	K	I	G
360	J	H	A
350	I	G	B
340	H	A	C
330	G	B	D
320	A	C	E
310	B	D	F
300	C	E	S
290	D	F	
280	E	S	
270	F		
260	S		
250	T		

LL Series (Total Rubber Thickness 16cm)

Outer diameter of rubber bearing, Do(mm) / Lead plug diameter, Dp(mm)	600	650	700	750	800	850	900	950	1000	1100	1200	1300
320												L
310												K
300											L	J
290											K	I
280											J	H
270										K	I	G
260										J	H	A
250									K	I	G	B
240								K	J	H	A	C
230							K	J	I	G	B	D
220						K	J	I	H	A	C	E
210						J	I	H	G	B	D	F
200					J	I	H	G	A	C	E	S
190				J	I	H	G	A	B	D	F	
180			J	I	H	G	A	B	C	E	S	
170		J	I	H	G	A	B	C	D	F		
160	J	I	H	G	A	B	C	D	E			
150	I	H	G	A	B	C	D	E	F			
140	H	G	A	B	C	D	E	F				
130	G	A	B	C	D	E	F					
120	A	B	C	D	E	F						
110	B	C	D	E								
100	C	D	E									
90	D	E										
80	E											

LS Series (S_2=5)

Outer diameter of rubber bearing, Do(mm) / Lead plug diameter, Dp(mm)	600	650	700	750	800	850	900	950	1000	1100	1200	1300	1400	1500
370														M
360														L
350														K
340													L	J
330													K	I
320												L	J	H
310												K	I	G
300											L	J	H	A
290											K	I	G	B
280											J	H	A	C
270										K	I	G	B	D
260										J	H	A	C	E
250									K	I	G	B	D	F
240								K	J	H	A	C	E	S
230								J	I	G	B	D	F	T
220							K	J	I	H	A	C	E	S
210							J	I	H	G	B	D	F	T
200						J	I	H	G	A	C	E	S	
190					J	I	H	G	A	B	D	F		
180				J	I	H	G	A	B	C	E	S		
170			J	I	H	G	A	B	C	D	F			
160	J	I	H	G	A	B	C	D	E	F				
150	I	H	G	A	B	C	D	E	F					
140	H	G	A	B	C	D	E	F						
130	G	A	B	C	D	E	F							
120	A	B	C	D	E	F								
110	B	C	D	E										
100	C	D	E											
90	D	E												
80	E													

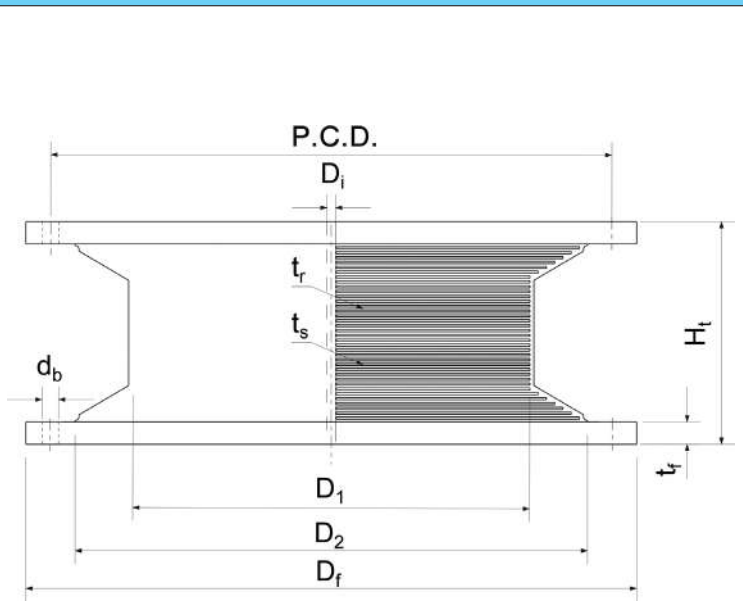
Product Specifications and Description of Performance Characteristics

High Damping Rubber Bearing (HDR): Flared Type (1/2)

This page provides the specifications and performance characteristics of the Flared Type. For the Conventional Type, please refer to pages 13 and 14.

Seismic Isolation Material Certification Number by Ministry of Land, Infrastructure, Transport and Tourism MVBR-0650-1 (X4T)

Product Dimension

	Characteristics	Sectional View
Physical Dimensions	Nominal rubber outer diameter (center) : D_1 (mm)	
	Maximum rubber outer diameter : D_2 (mm)	
	Effective outer diameter : $D_e(mm) = [(D_1^2 \cdot D_2 \cdot H_r) / \{D_1 \cdot (H_r - T_{r1}) + D_2 \cdot T_{r1}\}]^{1/2}$	
	Rubber inner diameter : D_i (mm)	
	Effective plane area : A ($\times 10^2 mm^2$)	
	Thickness of one rubber layer : t_r (mm)	
	Number of rubber layers : n	
	Total rubber thickness at center section : T_{r1} (mm)	
	Total rubber thickness at tapered section : T_{r2} (mm)	
	Total rubber thickness : $Hr = n \cdot t_r$ (mm)	
	First shape factor (based on effective outer diameter) : $S_1 = (D_e - D_i)/(4 \cdot t_r)$	
	Second shape factor (based on effective outer diameter) : $S_2 = D_e/(n \cdot t_r)$	
	Flange diameter : D_f (mm)	
	Flange thickness : t_f (mm)	
	Connecting bolt hole P.C.D. : P.C.D. (mm)	
	Connecting bolt hole diameter × quantity : d_b (mm) × quantity	
	Bolt size (assumption) : M (d_b-3)	
	Thickness of each reinforcing steel plate : t_s (mm)	
	Total product height : H_t (mm)	
	Total product weight (kN) =1/9.80665 (tonf)	

Rubber Material

Rubber code (standard temperature: 20° C, standard strain γ = 100%)

Rubber compound	Rubber code	Shear modulus G_{eq}(N/mm²)	Equivalent damping ratio H_{eq}
X4T	X0.4T	0.392	0.240

Composition of rubber materials (weight ratio %)

Rubber code		Natural rubber Synthetic rubber	Filler, reinforcement agent	Vulcanizing agent & others
Inner Rubber	X0.4T	35 and above	20 and above	45 and below
Cover Rubber		40 and above	15 and above	40 and below

Properties of rubber materials (some item names have been revised due to changes in JIS standards)

Item		Tensile strength (N/mm²)	Elongation at break (%)	Hardness	100% tensile stress (N/mm²)	Young's modulus E (N/mm²)	Bulk modulus E_∞ (N/mm²)	Correction factor κ due to rubber hardness
Test Standard		JIS K 6251	JIS K 6251	JIS K 6253	JIS K 6251	—	—	—
Inner Rubber	X0.4T	7 and above	840 and above	37 ± 8	0.43 ± 0.2	6.2	1300	1.0
Cover rubber		12 and above	600 and above	—	—	—	—	—

Steel Material

Steel material for each part

	Material
Reinforcing steel plate*3	SS400 (JIS G 3101)
Flange*2*3	SS400 (JIS G 3101) *1

*1: SM490A (JIS G 3106) is also available. (optional)
*2: Increased flange thickness other than standard thickness is also available. (optional)
*3: JIS-compliant steel products (blast-furnace or electric-furnace steel) manufactured at JIS-certified plants in Japan or overseas are used.

Flange anti-corrosion treatment

Surface preparation	Degreasing (alkaline cleaning or organic solvent degreasing); oxide removal; and flux treatment
Galvanizing	JIS H 8641 HDZT 77*1
Coating thickness	JIS H 0401 coating thickness t ≧ 77 (μ m)

*1: Due to the 2021 revision of the JIS standard, the designation was changed to HDZT 77. It corresponds to HDZ 55 under the previous standard.

Precautions

For applications such as mid-story seismic isolation, fire-resistant cover is required. Please contact fire resistant cover manufacturer who are listed in the JSSI manufacturer list (https://www.jssi.or.jp/seismicisolation_maker) for more details. Under JSSI regulations, HF095X4T and HF100X4T are not compatible with fire-resistant covers.

High Damping Rubber Bearing (HDR): Flared Type (2/2)

This page provides the specifications and performance characteristics of the Flared Type. For the Conventional Type, please refer to pages 13 and 14.

Shear Properties

Equivalent shear stiffness K_{eq}, equivalent damping ratio H_{eq}, initial stiffness K_1, post-yield stiffness K_2, characteristic strength Q_d, characteristic strength ratio u

The shear properties of HDR vary with shear strain amplitude. The shear strain dependency of each property is given by the following equations.

● Rubber material X0.4T ($0.1 \leqq \gamma \leqq 3.0$)

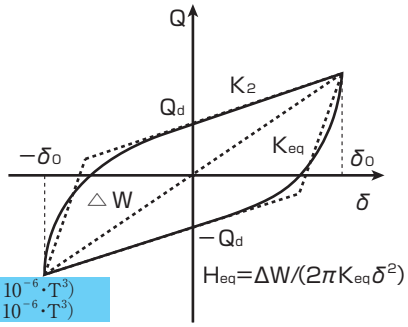
$$G_{eq}(\gamma) = -0.0244\gamma^5 + 0.2556\gamma^4 - 1.0192\gamma^3 + 1.9592\gamma^2 - 1.9087\gamma + 1.1295$$
$$H_{eq}(\gamma) = 0.0047\gamma^3 - 0.0307\gamma^2 + 0.0432\gamma + 0.2228$$
$$u(\gamma) = 0.0094\gamma^3 - 0.0604\gamma^2 + 0.0845\gamma + 0.3747$$

Based on above equations, each shear property shall be determined by the following equations.

Equivalent shear stiffness : $K_{eq} = G_{eq} \cdot A/H$ Equivalent damping ratio : $H_{eq} = \Delta W/(2\pi \cdot K_{eq}\delta^2)$

Initial stiffness : $K_1 = K_{eq}(u - \pi \cdot H_{eq}/2 + u \cdot \pi \cdot H_{eq}/2) / (u - \pi \cdot H_{eq}/2)$

Post-yield stiffness : $K_2 = K_{eq}(1 - u)$ Characteristic strength : $Q_d = u \cdot K_{eq} \cdot H \cdot \gamma$



Temperature dependency

Each shear property shall be corrected to the value at standard temperature of 20° C by the following equations.

Applicable range: − 10° C ≤ T ≤ 40° C ; T : Temperature at the time of inspection (° C)

● Rubber material X0.4T

$$K_{eq}(T℃) = K_{eq}(\text{standard value at } 20°C) \times (1.205 - 1.862\times10^{-2}\cdot T + 5.991\times10^{-4}\cdot T^2 - 8.991\times10^{-6}\cdot T^3)$$
$$H_{eq}(T℃) = H_{eq}(\text{standard value at } 20°C) \times (1.065 - 4.134\times10^{-3}\cdot T + 1.096\times10^{-4}\cdot T^2 - 3.102\times10^{-6}\cdot T^3)$$

● Standard value of temperature dependency Standard temperature (20° C)

Properties	Equivalent shear stiffness K_{eq}				Equivalent damping ration H_{eq}			
	− 10℃	0℃	30℃	40℃	− 10℃	0℃	30℃	40℃
X0.4T	Within+46%	Within + 21%	Within − 6%	Within − 16%	Within+12%	Within+7%	Within − 5%	Within − 13%

Performance variation

The variation rates for the main factors affecting shear properties, including manufacturing variation, aging, and temperature effects, are shown below.

Rubber material		X0.4T	
		Equivalent shear stiffness	Equivalent damping ratio Characteristic strength ratio
Manufacturing variation *1		± 10%	∓ 10%
Aging *2		+ 10%	− 10%
Ambient temperature variation 20℃± 20℃	(+)side	+ 21%	+ 7%
	(−)side	− 16%	− 13%
Total	(+)side *3 *4	+ 41%	− 13%
	(−)side *3 *4	− 26%	− 3%

＊1 : Under the Ministerial Certification, variation of individual products is specified to be within ± 20% of the standard value. However, as Bridgestone's internal standard, the total value of equivalent shear stiffness K_{eq} for all units in each project is controlled by rubber type as follows:
・8 units or more: within ± 10% of the total standard value
・2 to 7 units: within ± 15% of the total standard value
For the equivalent damping ratio Heq, the weighted average value, $\Sigma(H_{eq} \times K_{eq}) / \Sigma K_{eq}$, is controlled to the same variation range as above.
Reference: For compressive stiffness Kv, only individual product variation is controlled, within ± 30% of the standard value.
＊2 : Predicted rate of change after 60 years at 20° C standard temperature.
＊3 : The equivalent shear stiffness K_{eq} and equivalent damping ratio H_{eq} is dependent to each other. The indicated rate of change of H_{eq} are corresponding to both maximum and minimum rate of change of K_{eq} respectively.
＊4 : The table shows examples of combinations.

Compressive Properties

Compressive stiffness K_V

● Compressive stiffness K_v is determined by the following equation.

$$K_V = (-0.0570 \times S_2^* + 1.375) \times E_C \cdot \frac{A}{H} \qquad E_C = \frac{E(1+2\kappa S_1^{*2})}{1+E(1+2\kappa S_1^{*2})/E_\infty}$$

Ultimate Compressive Stress (refer figure on the right)

● Critical compressive stress σ_{cr} at zero shear strain is determined using the following equation.

$$\sigma_{cr} = \alpha_c \cdot \frac{\pi}{4}(G_{eq} \cdot E_b)^{0.5} \cdot S_2^*$$

However, $E_b = E_{cr}(1 + 2/3 \cdot \kappa \cdot S_1^{*2}) / \{1 + E_{cr}(1 + 2/3 \cdot \kappa \cdot S_1^{*2})/E_\infty\}$

[note] S_1^* is defined as 35.0 as standard value

α_c : Correction factor determined from our test data

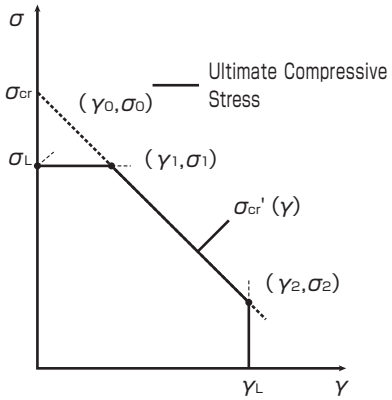
Rubber material X0.4T : α_c=1.80 (if $\gamma_{\omega 0} \geqq 6$) $\alpha_c = (1.80\{1 - 0.30(6 - \gamma_{\omega 0})\}$ (if $6 > \gamma_{\omega 0}$)

E_{cr}=3 × G_{eq} (=3 × 0.392=1.176)

● Ultimate compressive stress at any shear strain $\sigma_{cr}'(\gamma)$ is determined by σ_{cr} by the following equation.

$$\sigma_{cr}'(\gamma) = \sigma_{cr} \times \left(1 - \frac{\gamma}{\gamma_{\omega 0}}\right)$$

$\gamma_{\omega 0}$: Shear strain at which the overlap area becomes zero (For flared type $\gamma_{\omega 0} = D_2/H_r$)



● The ultimate compressive stress shall not exceed the upper limit σ_L determined as below and the strain region corresponding to the ultimate strain γ_L at 0 compressive stress.

σ_L=45 ($S_2^* \geqq 4.9$) σ_L=45 + 10 ($S_2^* - 5$)($4.9 > S_2^*$)

$\gamma_L$is defined as minimum value among ⌈400% ($0.9 \times \gamma_{\omega 0} \geqq 4$) $\gamma_{\omega 0} \times 0.9 \times 100\%$ ($0.9 \times \gamma_{\omega 0} < 4$)⌋、⌈$\gamma_{\omega 0} \times (1 - \sigma/\sigma_{cr}) \times 100\%$⌋、⌈$(580 \times a \times S_2^* + d_e^3 \times 905)/(a \times d_e^2 \times S_2^* + d_e^3 \times 4.49)$⌋

Where,

d_e : dimensionless quantity obtained by dividing effective outer diameter by nominal center rubber outer diameter (=D_e / D_i)

a : dimensionless quantity obtained by dividing total rubber thickness by total rubber thickness at the center (=H_r / T_{ri})

$\gamma_{\omega 0}$: Shear strain at which the overlap area becomes zero (For flared type $\gamma_{\omega 0} = D_2/H_r$)

High Damping Rubber Bearing (HDR) (1/2)

This page provides the specifications and performance characteristics of the Conventional Type. For the Flared Type, please refer to pages 11 and 12.

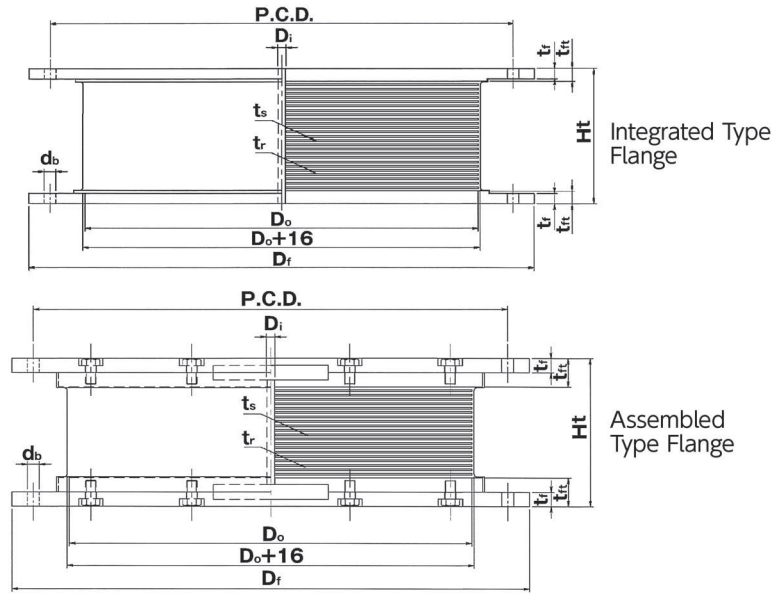
Seismic Isolation Material Certification Number by Ministry of Land, Infrastructure, Transport and Tourism

MVBR-0516 (X3R)
MVBR-0510/MVBR-0519 (X4S)
MVBR-0514/MVBR-0520 (X6R)

Evaluation Number for Revised Notification No. 1446

BCJ Evaluation-IB8001-01

Product Dimension

Characteristics		Sectional View
Physical Dimensions	Rubber outer diameter : D_0 (mm)	
	Rubber inner diameter : D_i (mm)	
	Number of inner diameter : n_i	
	Effective plane area : A ($\times 10^2 mm^2$)	
	Thickness of one rubber layer : t_r (mm)	
	Number of rubber layers : n	
	Total rubber thickness : $H = n \cdot t_r$ (mm)	
	First shape factor $S_1 = (D_0^2 - n_i \cdot D_i^2)/\{4 \cdot t_r \cdot (D_0 + n_i \cdot D_i)\}$	
	Second shape factor $S_2 = D_0/(n \cdot t_r)$	
	Flange diameter : D_f (mm)	
	Flange thickness: edge/center : t_f/t_{ft} (mm)	
	Connecting bolt hole P.C.D. : P.C.D. (mm)	
	Connecting bolt hole diameter × quantity : d_b (mm) × quantity	
	Bolt size (assumption) : M (d_b—3)	
	Thickness of each reinforcing steel plate : t_s (mm)	
	Total product height : H_t (mm)	
	Total product weight 1 (kN) = 1/9.80665 (tonf)	

Rubber Material

Rubber code (standard temperature: 20° C, standard strain γ = 100%)

Rubber compound	Rubber code	Shear modulus G_{eq} (N/mm^2)	Equivalent damping ratio H_{eq}
X3R	X0.3R	0.300	0.170
X4S	X0.4S	0.392	0.240
X6R	X0.6R	0.620	0.240

Composition of rubber materials (weight ratio %)

Rubber code		Natural rubber Synthetic rubber	Filler, reinforcement agent	Vulcanizing agent & others
Inner Rubber	X0.3R	35 and above	15 and above	50 and below
	X0.4S	35 and above	20 and above	45 and below
	X0.6R	35 and above	25 and above	40 and below
Cover Rubber		40 and above	15 and above	40 and below

Properties of rubber materials (some item names have been revised due to changes in JIS standards)

Item		Tensile strength (N/mm^2)	Elongation at break (%)	Hardness	100% tensile stress (N/mm^2)	Young's modulus E (N/mm^2)	Bulk modulus E_∞ (N/mm^2)	Correction factor κ due to rubber hardness
Test Standard		JIS K 6251	JIS K 6251	JIS K 6253	JIS K 6251	—	—	—
Inner Rubber	X0.3R	7 and above	700 and above	34 ± 8	0.53 ± 0.2	4.0	1150	1.0
	X0.4S	7 and above	840 and above	37 ± 8	0.43 ± 0.2	6.2	1300	1.0
	X0.6R	8.5 and above	780 and above	53 ± 5	0.73 ± 0.2	7.6	1500	1.0
Cover Rubber		12 and above	600 and above	—	—	—	—	—

Steel Material

Steel material for each part

	Material
Reinforcing steel plate*3	SS400 (JIS G 3101)
Flange*2*3	SS400 (JIS G 3101) *1
Connecting plate*3	SS400 (JIS G 3101) *1

*1: SM490A (JIS G 3106) is also available. (optional)
*2: Increased flange thickness other than standard thickness is also available. (optional)
*3: JIS-compliant steel products (blast-furnace or electric-furnace steel) manufactured at JIS-certified plants in Japan or overseas are used.

Flange anti-corrosion treatment

Surface preparation	Degreasing (alkaline cleaning or organic solvent degreasing); oxide removal; and flux treatment
Galvanizing	JIS H 8641 HDZT 77*1
Coating thickness	JIS H 0401 coating thickness $t \geqq 77$ (μ m)

*1: Due to the 2021 revision of the JIS standard, the designation was changed to HDZT 77. It corresponds to HDZ 55 under the previous standard.

Precautions

- For applications such as mid-story seismic isolation, fire-resistant cover is required. Please contact fire resistant cover manufacturer who are listed in the JSSI manufacturer list (https://www.jssi.or.jp/seismicisolation_maker) for more details. Under JSSI regulations, HS110X4S are not compatible with fire-resistant covers. For X3R, an increased-thickness flange is required as flange thickness below 20 mm are not applicable for fire-resistant covers.
- There are two certification numbers for X0.4S, X0.6R due to difference of some manufacturing process. Although their properties values are the same, please fill the certification number as shown in the table on the right in the design documents.

	Rubber size ϕ 1000 and below	Rubber size ϕ 1100 and above
X0.4S	Both MVBR-0510/MVBR-0519	MVBR-0510 only
X0.6R	Both MVBR-0514/MVBR-0520	MVBR-0514 only

High Damping Rubber Bearing (HDR) (2/2)

This page provides the specifications and performance characteristics of the Conventional Type. For the Flared Type, please refer to pages 11 and 12.

Shear Properties

Equivalent shear stiffness K_{eq}, equivalent damping ratio H_{eq}, initial stiffness K_1, post-yield stiffness K_2, characteristic strength Q_d, characteristic strength ratio u

The shear properties of HDR vary with shear strain amplitude. The shear strain dependency of each property is given by the following equations.

● Rubber material X0.3R ($0.1 \leqq \gamma \leqq 3.0$)

$$G_{eq}(\gamma) = 0.0255\gamma^4 - 0.2213\gamma^3 + 0.7283\gamma^2 - 1.1028\gamma + 0.8703$$
$$H_{eq}(\gamma) = -0.005\gamma^3 + 0.015\gamma^2 - 0.006\gamma + 0.166$$
$$u(\gamma) = -0.0087\gamma^3 + 0.0262\gamma^2 - 0.0105\gamma + 0.2720$$

● Rubber material X0.4S ($0.1 \leqq \gamma \leqq 2.7$)

$$G_{eq}(\gamma) = 0.054\gamma^4 - 0.416\gamma^3 + 1.192\gamma^2 - 1.583\gamma + 1.145$$
$$H_{eq}(\gamma) = -0.007\gamma^3 + 0.020\gamma^2 - 0.009\gamma + 0.236$$
$$u(\gamma) = -0.0132\gamma^3 + 0.0401\gamma^2 - 0.0190\gamma + 0.4001$$

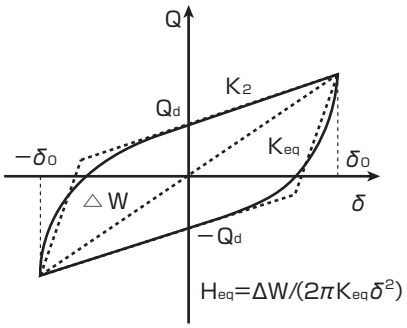
● Rubber material X0.6R ($0.1 \leqq \gamma \leqq 2.7$)

$$G_{eq} = 0.620 \times (0.1364\gamma^4 - 1.016\gamma^3 + 2.903\gamma^2 - 3.878\gamma + 2.855)$$
$$H_{eq} = 0.240 \times (0.02902\gamma^3 - 0.1804\gamma^2 + 0.2364\gamma + 0.9150)$$
$$u(\gamma) = 0.408 \times (0.03421\gamma^3 - 0.2083\gamma^2 + 0.2711\gamma + 0.9028)$$

Based on above equations, each shear property shall be determined by the following equations.

Equivalent shear stiffness: $K_{eq} = G_{eq} \cdot A/H$ Equivalent damping ratio: $H_{eq} = \Delta W/(2\pi \cdot K_{eq} \delta^2)$
Initial stiffness: $K_1 = 10 \times K_2$ *1 Post-yield stiffness: $K_2 = K_{eq}(1-u)$ Characteristic strength: $Q_d = u \cdot K_{eq} \cdot H \cdot \gamma$

*1 : At standard condition only and shall be excluded when considering the properties variation.



Temperature dependency

Temperature dependency

Applicable range: $-10^\circ C \leq T \leq 40^\circ C$; T : Temperature at the time of inspection (° C)

● Rubber material X0.3R

$$K_{eq}(T℃) = K_{eq}(\text{standard value at } 20℃) \times (1.139 - 9.653\times10^{-3}\cdot T + 1.721\times10^{-4}\cdot T^2 - 1.847\times10^{-6}\cdot T^3)$$
$$H_{eq}(T℃) = H_{eq}(\text{standard value at } 20℃) \times (1.050 - 2.790\times10^{-3}\cdot T + 4.678\times10^{-5}\cdot T^2 - 1.613\times10^{-6}\cdot T^3)$$

● Rubber material X0.4S/X0.6R

$$K_{eq}(T℃) = K_{eq}(\text{standard value at } 20℃) \times (1.205 - 1.862\times10^{-2}\cdot T + 5.991\times10^{-4}\cdot T^2 - 8.991\times10^{-6}\cdot T^3)$$
$$H_{eq}(T℃) = H_{eq}(\text{standard value at } 20℃) \times (1.065 - 4.134\times10^{-3}\cdot T + 1.096\times10^{-4}\cdot T^2 - 3.102\times10^{-6}\cdot T^3)$$

● Standard value of temperature dependency Standard temperature (20° C)

Properties	Equivalent shear stiffness K_{eq}				Equivalent damping ration H_{eq}			
	−10℃	0℃	30℃	40℃	−10℃	0℃	30℃	40℃
X0.3R	+25%	Within +14%	Within −5%	Within −9%	Within +8%	Within +5%	Within −4%	Within −9%
X0.4S	+46%	Within +21%	Within −6%	Within −16%	Within +12%	Within +7%	Within −4%	Within −12%
X0.6R	+46%	Within +21%	Within −6%	Within −16%	Within +12%	Within +7%	Within −5%	Within −13%

Performance variation

The variation rates for the main factors affecting shear properties, including manufacturing variation, aging, and temperature effects, are shown below.

Rubber material		X0.3R		X0.4S		X0.6R	
		Equivalent shear stiffness	Equivalent damping ratio Characteristic strength ratio	Equivalent shear stiffness	Equivalent damping ratio Characteristic strength ratio	Equivalent shear stiffness	Equivalent damping ratio Characteristic strength ratio
Manufacturing variation *1		±10%	∓10%	±10%	∓10%	±10%	∓10%
Aging *2		+10%	−10%	+10%	−10%	+10%	−10%
Ambient temperature variation 20℃±20℃	(+)side	+14%	+5%	+21%	+7%	+21%	+7%
	(−)side	−9%	−9%	−16%	−12%	−16%	−13%
Total	(+)side *3 *4	+34%	−15%	+41%	−13%	+41%	−13%
	(−)side *3 *4	−19%	+1%	−26%	−2%	−26%	−3%

*1 : Regardless of the manufacturing method, individual product variation shall be within ± 20% of the standard value. The total value of equivalent shear stiffness Keq for all units in each project is controlled by rubber type and its quantity as follows:
・8 units or more: within ± 10% of the total standard value
・2 to 7 units: within ± 15% of the total standard value
For the equivalent damping ratio Heq, the weighted average value, $\Sigma(H_{eq} \times K_{eq}) / \Sigma K_{eq}$ is controlled to the same variation range as above.
Reference: For compressive stiffness K_v only individual product variation is controlled to be within ± 30% of the standard value.

*2 : Predicted rate of change after 60 years at 20° C standard temperature.

*3 : The equivalent shear stiffness K_{eq} and equivalent damping ratio H_{eq} is dependent to each other. The indicated rate of change of H_{eq} are corresponding to both maximum and minimum rate of change of K_{eq} respectively

*4 : The table shows examples of combinations.

Compressive Properties

Compressive stiffness K_V

● Compressive stiffness K_v is determined by the following equation.

$$K_V = E_C \cdot \frac{A}{H} \qquad E_C = \frac{E(1+2\kappa S_1^2)}{1+E(1+2\kappa S_1^2)/E_\infty}$$

Ultimate Compressive Stress

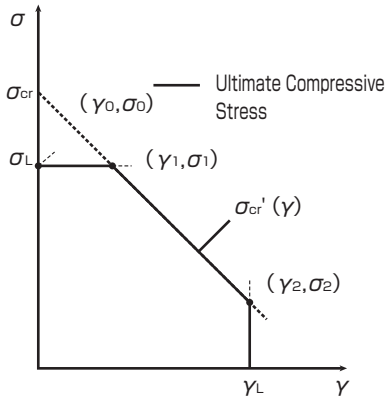
● Critical stress σ_{cr} at zero shear strain is determined by the following equation.

$$\sigma_{cr} = \alpha_c \cdot \frac{\pi}{4}(G_{eq} \cdot E_b)^{0.5} \cdot S_2$$

Where, $E_b = E_{cr}(1 + 2/3 \cdot \kappa \cdot S_1^2) / \{1 + E_{cr}(1 + 2/3 \cdot \kappa \cdot S_1^2)/E_\infty\}$
(NOTE) S_1 is definded as 35.0 [for X0.4S,X06R] and 28.0[for X0.3R] as standard value.
α_c : Correction factor determined from our test data
Rubber material X0.3R : α_c=1.0 (if $S_2 \geqq 5$) $\alpha_c = (1 - 0.2(5 - S_2))$ (if $5 > S_2$)
Rubber material X0.4S : α_c=0.88 (if $S_2 \geqq 5$) $\alpha_c = 0.88(1 - 0.07(5 - S_2))$ (if $5 > S_2$)
Rubber material X0.6R : α_c=1.45 (if $S_2 \geqq 5$) $\alpha_c = 1.45 - 0.3(5 - S_2)$ (if $5 > S_2$)
E_{cr}=3 × G_{eq} (for X0.4S/X0.6R) E_{cr}=2.2 (X0.3R)

● Ultimate compressive stress at any shear strain $\sigma_{cr}'(\gamma)$ is determined by σ_{cr} by the following equation.

$$\sigma_{cr}'(\gamma) = \sigma_{cr} \cdot \left(1 - \frac{\gamma}{S_2}\right)$$



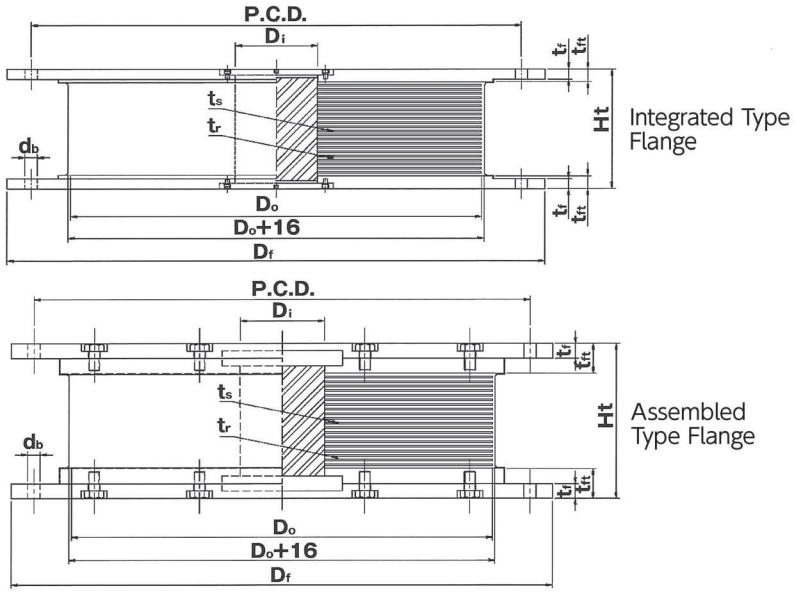
● The ultimate compressive stress shall not exceed the upper limit σ_L determined as below and the strain region corresponding to the ultimate strain γ_L at 0 compressive stress.

Rubber material X0.3R : σ_L=40 (if $S_2 \geqq 5.0$) $\sigma_L = 40 + 10(S_2 - 5)$ (if $5.0 > S_2 \geqq 3.0$)
γ_L is defined as minimum value among 「400%」, 「$S_2 \times 0.9 \times 100\%$」, 「$(5.80 \times S_2 + 7.10)/(S_2 + 3.45) \times 100\%$」, 「$S_2 \times (\sigma/\sigma_{cr}) \times 100\%$」
Rubber material X0.4S : σ_L=45 (if $S_2 \geqq 4.9$) $\sigma_L = 45 + 10(S_2 - 5)$ (if $4.9 > S_2 \geqq 4.0$) $\sigma_L = 40 + 10(S_2 - 5)$ (if $4.0 > S_2 \geqq 3.0$)
γ_L is defined as minimum value among 「400%」, 「$S_2 \times 0.9 \times 100\%$」, 「$(5.80 \times S_2 + 9.05)/(S_2 + 4.49) \times 100\%$」, 「$S_2 \times (\sigma/\sigma_{cr}) \times 100\%$」
Rubber material X0.6R : σ_L=60 (if $S_2 \geqq 4.9$) $\sigma_L = 48 + 14(S_2 - 4)$ (if $4.9 > S_2 \geqq 4.0$)
$\sigma_L = 24 + 24(S_2 - 3)$ (if $4.0 > S_2 \geqq 3.5$) $\alpha_L = 22 + 28(S_2 - 3)$ (if $3.5 > S_2 \geqq 3.0$)
γ_L is defined as minimum value among 「400%」, 「$S_2 \times 0.9 \times 100\%$」, 「$(5.00 \times S_2 + 9.05)/(S_2 + 4.49) \times 100\%$」

Lead Rubber Bearing (LRB) (1/2)

Seismic Isolation Material Certification Number by Ministry of Land, Infrastructure, Transport and Tourism MVBR-0517
Evaluation Number for Revised Notification No. 1446 BCJ Evaluation-IB8003-01

Product Dimension

Characteristics		Sectional View
Physical Dimensions	Rubber outer diameter : D_0 (mm)	
	Lead plug diameter : D_i (mm)	
	Effective plane area : A_r ($\times 10^2 mm^2$)	
	Thickness of one rubber layer : t_r (mm)	
	Number of rubber layers : n	
	Total rubber thickness : $H = n \cdot t_r$ (mm)	
	First shape factor $S_1 = (D_0) / (4 \cdot t_r)$	
	Second shape factor $S_2 = D_0 / (n \cdot t_r)$	
	Flange diameter : D_f (mm)	
	Flange thickness: edge/center : t_r/t_{ft} (mm)	
	Connecting bolt hole P.C.D. : P.C.D. (mm)	
	Connecting bolt hole diameter × quantity : d_b (mm) × quantity	
	Bolt size (assumption) : M (d_b−3)	
	Thickness of each reinforcing steel plate : t_s (mm)	
	Total product height : H_t (mm)	
	Total product weight 1 (kN) = 1/9.80665 (tonf)	

Rubber Material

Rubber code (standard temperature: 20° C, standard strain γ = 100%)

Rubber compound	Rubber code	Shear modulus G_{eq}(N/mm²)
G4	G0.4	0.385

Composition of rubber materials (weight ratio %)

Rubber code	Natural rubber Synthetic rubber	Filler, reinforcement agent	Vulcanizing agent & others
Inner Rubber (G0.4)	60 and above	10 and above	25 and below
Cover Rubber	40 and above	15 and above	40 and below

Properties of rubber materials (some item names have been revised due to changes in JIS standards)

Item	Tensile strength (N/mm²)	Elongation at break (%)	Hardness	100% tensile stress (N/mm²)	Young's modulus E (N/mm²)	Bulk modulus E_∞ (N/mm²)	Correction factor κ due to rubber hardness
Test Standard	JIS K 6251	JIS K 6251	JIS K 6253	JIS K 6251	—	—	—
Inner Rubber	17 and above	600 and above	37 ± 5	0.8 ± 0.2	2.20	1176	0.85
Cover Rubber	12 and above	600 and above	—	—	—	—	—

Steel Material

Steel material for each part

	Material
Reinforcing steel plate *3	SS400 (JIS G 3101)
Flange *2 *3	SS400 (JIS G 3101) *1
Connecting plate *3	SS400 (JIS G 3101) *1
Lead plug	Pb (JIS H 2105 special)

*1: SM490A (JIS G 3106) is also available. (optional)
*2: Increased flange thickness other than standard thickness is also available. (optional)
*3: JIS-compliant steel products (blast-furnace or electric-furnace steel) manufactured at JIS-certified plants in Japan or overseas are used.

Flange anti-corrosion treatment

Surface preparation	Degreasing (alkaline cleaning or organic solvent degreasing); oxide removal; and flux treatment	
Galvanizing	JIS H 8641	HDZT 77 *1
Coating thickness	JIS H 0401	coating thickness t ≧ 77 (μ m)

*1 : Due to the 2021 revision of the JIS standard, the designation was changed to HDZT 77. It corresponds to HDZ 55 under the previous standard.

Precautions

- Due to the lead plug embedded in the center of the laminated rubber body, special treatment is required in case the laminated rubber bearing is to be treated as industrial waste.
- For applications such as mid-story seismic isolation, fire-resistant cover is required. Please contact fire resistant cover manufacturer who are listed in the JSSI manufacturer list (https://www.jssi.or.jp/seismicisolation_maker) for more details. Under JSSI regulations, J-Type of rubber diameter Φ 600mm～Φ 750mm and K-Type of rubber diameter Φ 850mm～Φ 950mm are not compatible with fire-resistant covers.

Lead Rubber Bearing (LRB) (2/2)

Shear Properties

Equivalent shear stiffness K_{eq}, equivalent damping ratio H_{eq}, initial stiffness K_1, post-yield stiffness K_2, characteristic strength Q_d

The shear properties of LRB vary with shear strain amplitude. The shear strain dependency of each property is given by the following equations.

Post-yield stiffness : $K_2 = K_d = C_{Kd} \cdot (K_r + K_p)$

Shear stiffness of laminated rubber : $K_r = G_r \cdot A_r / H$ Additional shear stiffness by lead plug : $K_p = \alpha_p \cdot A_p / H$

Where, C_{Kd} : post-yield stiffness correction factor due to strain dependency

G_r : shear modulus of rubber 0.385 N/mm²

γ : shear strain

α_p : apparent shear modulus of lead 0.583 N/mm²

$$C_{Kd} \begin{cases} 0.779\,\gamma^{-0.43} & [\gamma < 0.25] \\ \gamma^{-0.25} & [0.25 \leqq \gamma < 1.0] \\ \gamma^{-0.12} & [1.0 \leqq \gamma \leqq 2.5] \end{cases}$$

Characteristics strength : $Q_d = C_{Qd} \cdot \sigma_{pb} \cdot A_p$

Where, C_{Qd} : characteristic strength correction factor due to strain dependency

σ_{pb} : Shear stress at yield of lead 7.967 N/mm²

$$C_{Qd} \begin{cases} 2.036\,\gamma^{0.41} & [\gamma \leqq 0.1] \\ 1.106\,\gamma^{0.145} & [0.1 < \gamma < 0.5] \\ 1 & [0.5 \leqq \gamma] \end{cases}$$

Initial stiffness : $K_1 = \beta \cdot K_d$

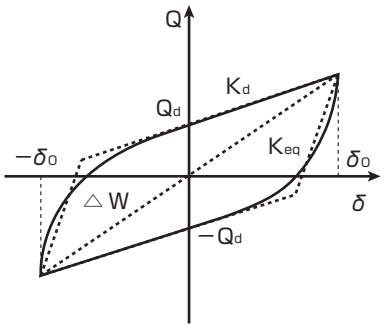
Where, β : Ratio of initial stiffness to post-yield stiffness which is between 10 ~ 15. (recommended value: 13)

Equivalent shear stiffness K_{eq}

$$K_{eq} = \frac{Q_d}{\gamma \cdot H} + K_d$$

Equivalent damping ratio H_{eq}

$$H_{eq} = \frac{2}{\pi} \cdot \frac{\left\{ Q_d\,\gamma \cdot H - \frac{Q_d}{(\beta - 1)\,K_d} \right\}}{K_{eq} \cdot (\gamma \cdot H)^2}$$



Temperature dependency

Each shear property shall be corrected to the value at standard temperature of 20° C by the following equations.

Applicable range: − 10° C ≤ T ≤ 40° C ; T : Temperature at the time of inspection (° C)

● Temperature correction equation

: $K_d\,(T℃) = K_d$ (standard value at 20℃) × $(1.052 - 2.955 \times 10^{-3} \cdot T + 1.895 \times 10^{-5} \cdot T^2)$

: $Q_d\,(T℃) = Q_d$ (standard value at 20℃) × $(1.192 - 1.017 \times 10^{-2} \cdot T + 2.722 \times 10^{-5} \cdot T^2)$

● Standard value of temperature dependency Standard temperature (20° C) *1

Properties	− 10℃	0℃	30℃	40℃
Post-yield stiffness K_d	+ 10%	+ 6%	− 3%	− 5%
Characteristic strength Q_d	+ 36%	+ 23%	− 11%	− 21%

*1 : The standard value takes into account the variation of 20% to the value obtained by the temperature correction equation.

Performance variation

The variation rates for the main factors affecting shear properties, including manufacturing variation, aging, and temperature effects, are shown below.

Rubber material		G0.4	
Properties		Post-yield stiffness K_d	Characteristic strength Q_d
Manufacturing variation *2		Within ± 10%	Within ± 10%
Aging *3		Within + 10%	−
Ambient temperature variation 20℃± 20℃	(+) side	Within + 6%	Within + 23%
	(−) side	Within − 5%	Within − 21%
Total	(+) side *4	Within + 26%	Within + 33%
	(−) side *4	Within − 15%	Within − 31%

*2 : The individual product variation shall be within ± 20% of the standard value. The total value of product variation for all units in each project is controlled by quantity as follows:

・8 units or more: within ± 10% of the total standard value

・2 to 7 units: within ± 15% of the total standard value

Reference: For compressive stiffness K_v, only individual product variation is controlled to be within ± 20% of the standard value.

*3 : Predicted rate of change after 60 years at 20° C standard temperature.
(20% variation is considered in the rate of change)

*4 : The table shows examples of combinations.

Compressive Properties

Compressive stiffness K_V

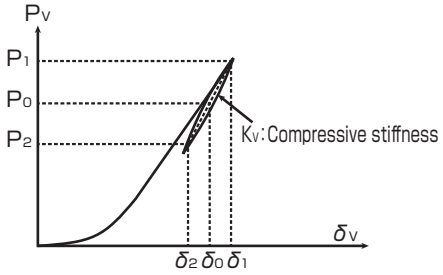
● Compressive stiffness K_v is determined by the following equation.

$$K_V = \alpha_V \cdot E_C \cdot \frac{A}{H} \qquad E_C = \frac{E(1 + 2\kappa S_1^2)}{1 + E(1 + 2\kappa S_1^2)/E_\infty}$$

A : Laminated rubber plane are A_r : Effective plane area A_p : Lead plug plane area

$A = A_r + A_p$

α_V : Young's modulus correction factor = 1.23



Ultimate Compressive Stress (refer figure on the right)

● Critical stress σ_{cr} at zero shear strain is determined using the following equation.

$$\sigma_{cr} = \frac{\pi}{4} \cdot 1.26 \cdot \alpha_c \cdot (G_{eq} \cdot E_b)^{0.5} \cdot S_2$$

Where, $E_b = E\,(1 + 2/3 \cdot \kappa \cdot S_1^2) / \{1 + E\,(1 + 2/3 \cdot \kappa \cdot S_1^2) / E_\infty\}$

α_c : Correction factor based on S_2 determined from our test data

if $S_2 \geqq 5$: $\alpha_c = 1$, if $S_2 < 5$: $\alpha_c = 0.25 \cdot (S_2 - 5) + 1$

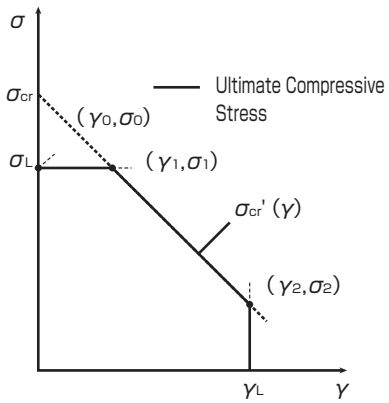
● Ultimate compressive stress at any shear strain $\sigma_{cr}'(\gamma)$ is determined by σ_{cr} by the following equation.

$$\sigma_{cr}'(\gamma) = \sigma_{cr} \cdot \left(1 - 0.9\,\frac{\gamma}{S_2}\right)$$

● The ultimate compressive stress shall not exceed the upper limit σ_L determined as below and the strain region corresponding to the ultimate strain γ_L at 0 compressive stress.

$\sigma_L = 60$ (N/mm²)

$\gamma_L = \min 400\%\,,\ S_2 \times 100\%$

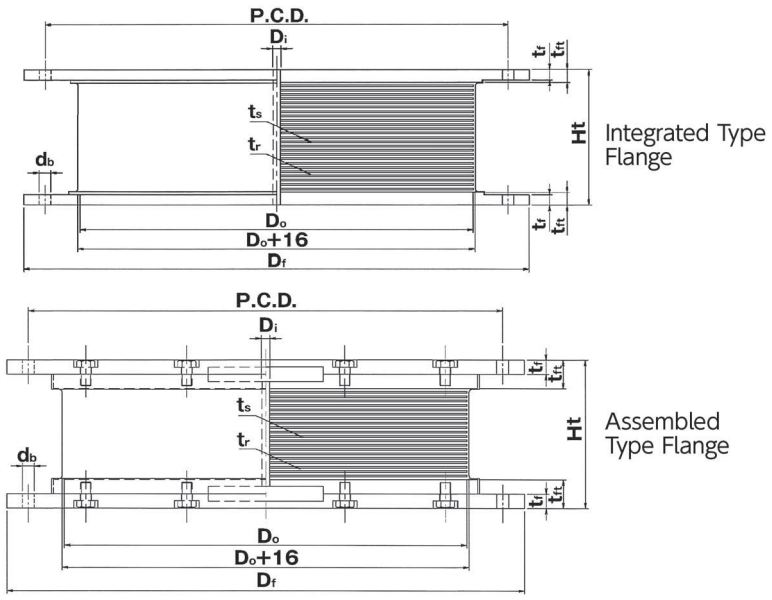


Natural Rubber Bearing (NRB) (1/2)

Seismic Isolation Material Certification Number by Ministry of Land, Infrastructure, Transport and Tourism
Evaluation Number for Revised Notification No. 1446

MVBR-0295 (N3、G3、G5)
MVBR-0509/MVBR-0518/MVBR-0540 (G4)
BCJ Evaluation-IB8002-01

Product Dimension

Characteristics		Sectional View
Physical Dimensions	Rubber outer diameter : D_0 (mm)	
	Rubber inner diameter : D_i (mm)	
	Number of inner diameter : n_i	
	Effective plane area : A ($\times 10^2$mm^2)	
	Thickness of one rubber layer : t_r (mm)	
	Number of rubber layers : n	
	Total rubber thickness : $H = n \cdot t_r$ (mm)	
	First shape factor $S_1 = (D_0^2 - n_i \cdot D_i^2)/\{4 \cdot t_r \cdot (D_0 + n_i \cdot D_i)\}$	
	Second shape factor $S_2 = D_0/(n \cdot t_r)$	
	Flange diameter : D_f (mm)	
	Flange thickness: edge/center : t_f/t_{ft} (mm)	
	Connecting bolt hole P.C.D. : P.C.D. (mm)	
	Connecting bolt hole diameter × quantity : d_b (mm) × quantity	
	Bolt size (assumption) : M (d_b−3)	
	Thickness of each reinforcing steel plate : t_s (mm)	
	Total product height : H_t (mm)	
	Total product weight 1 (kN) = 1/9.80665 (tonf)	

Rubber Material

Rubber code (standard temperature: 20° C, standard strain γ = 100%)

Rubber compound	Rubber code	Shear modulus G_{eo}(N/mm^2)
N3	G0.30	0.294
G3	G0.35	0.343
G4	G0.40	0.392
G5	G0.45	0.441

Composition of rubber materials (weight ratio %)

Rubber code		Natural rubber Synthetic rubber	Filler, reinforcement agent	Vulcanizing agent & others
Inner Rubber	G0.30	55 and above	15 and above	25 and below
	G0.35	60 and above	10 and above	25 and below
	G0.40	60 and above	10 and above	25 and below
	G0.45	65 and above	10 and above	20 and below
Cover Rubber		40 and above	15 and above	40and below

Properties of rubber materials (some item names have been revised due to changes in JIS standards)

Item		Tensile strength (N/mm^2)	Elongation at break (%)	Hardness	100% tensile stress (N/mm^2)	Young's modulus E (N/mm^2)	Bulk modulus E_∞ (N/mm^2)	Correction factor κ due to rubber hardness
Test Standard		JIS K 6251	JIS K 6251	JIS K 6253	JIS K 6251	—	—	—
Inner Rubber	G0.30	14 and above	600 and above	33 ± 4	0.6 ± 0.2	1.64	1200	0.85
	G0.35	16 and above	600 and above	33 ± 4	0.7 ± 0.2	1.92	1200	0.85
	G0.40	17 and above	600 and above	37 ± 5	0.8 ± 0.2	2.20	1200	0.85
	G0.45	17 and above	600 and above	40 ± 5	0.9 ± 0.2	2.47	1300	0.85
Cover Rubber		12 and above	600 and above	—	—	—	—	—

Steel Material

Steel material for each part

	Material
Reinforcing steel plate *3	SS400 (JIS G 3101)
Flange *2 *3	SS400 (JIS G 3101) *1
Connecting plate *3	SS400 (JIS G 3101) *1

*1: SM490A (JIS G 3106) is also available. (optional)
*2: Increased flange thickness other than standard thickness is also available. (optional)
*3: JIS-compliant steel products (blast-furnace or electric-furnace steel) manufactured at JIS-certified plants in Japan or overseas are used.

Flange anti-corrosion treatment

Surface preparation	Degreasing (alkaline cleaning or organic solvent degreasing); oxide removal; and flux treatment
Galvanizing	JIS H 8641 HDZT 77 *1
Coating thickness	JIS H 0401 coating thickness t ≧ 77 (μ m)

*1 : Due to the 2021 revision of the JIS standard, the designation was changed to HDZT 77. It corresponds to HDZ 55 under the previous standard.

Precautions

- For applications such as mid-story seismic isolation, fire-resistant cover is required. Please contact fire resistant cover manufacturer who are listed in the JSSI manufacturer list (https://www.jssi.or.jp/seismicisolation_maker) for more details.
- There are two certification numbers for G0.4 due to difference of some manufacturing process. Although their properties values are the same, please fill the certification number as shown in the table on the right in the design documents. When the tensile strain criterion under MVBR-0540 is used for design, MVBR-0540 should be indicated regardless of the rubber diameter.

Rubber size ϕ 1000 and below	Rubber size ϕ 1100 and above
Both MVBR-0509/MVBR-0518	MVBR-0509 only

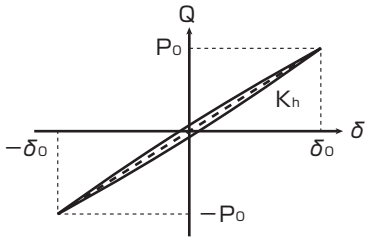
Natural Rubber Bearing (NRB) (2/2)

Shear Properties

Shear shear stiffness K_h

NRB shows linear restoring force characteristics in horizontal direction.
Shear stiffness K_h is determined by the following equation

$$K_h = \frac{G_{eq} \cdot A}{H}$$



δ_0 : Displacement corresponding to 100% Shear Strain
P_0 : Maximum Load
K_h : Horizontal Stiffness (Initial Stiffness)
G_{eq} : Shear Modulus (Shear Elastic Modulus)

Temperature dependency

The shear stiffness shall be corrected to the value at standard temperature of 20° C by the following equations.
Applicable range: − 10° C ≤ T ≤ 40° C ; T : Temperature at the time of inspection (° C)

● Temperature correction equation: $K_h(T℃) = K_h(\text{standard value at } 20℃) \times (1.052 - 2.955 \times 10^{-3} \cdot T + 1.895 \times 10^{-5} \cdot T^2)$ (Applied to all rubber codes

● Standard value of temperature dependency Standard temperature (20° C) *1

Properties	− 10℃	0℃	30℃	40℃
Shear stiffness K_h	+ 8%	+ 6%	− 3%	− 5%

*1 : The standard value takes into account the variation of 20% to the value obtained by the temperature correction equation.

Performance variation

The variation rates for the main factors affecting shear properties, including manufacturing variation, aging, and temperature effects, are shown below.

Rubber material		Common
Properties		Shear stiffness K_h
Manufacturing variation *2		Within ± 10%
Aging *3		Within + 10%
Ambient temperature variation 20℃± 20℃	(+) side	Within + 6%
	(−) side	Within − 5%
Total	(+) side *4	Within + 26%
	(−) side *4	Within − 15%

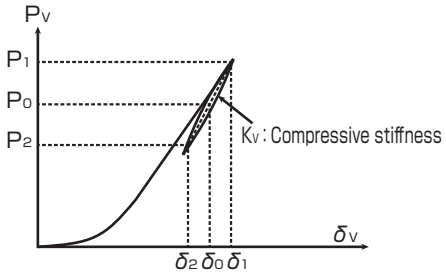
*2 : Regardless of the manufacturing method, individual product variation for all types of Natural Rubber Bearing shall be within ± 20% of the standard value.
[When MVBR-0295 (rubber codes G0.30, G0.35, G0.45) is not included]
Regardless of the manufacturing method, the total value of all units in each project shall be controlled as follows:
・8 units or more: within ± 10% of the total standard value
・2 to 7 units: within ± 15% of the total standard value
[When MVBR-0295 (rubber codes G0.30, G0.35, G0.45) is included]For all Natural Rubber Bearing rubber types, when 2 or more units are used, the total value of all units in each project shall be within ± 10% of the total standard value, regardless of the number of units.
Reference: For compressive stiffness K_v, only individual product variation is controlled to be within ± 30% of the standard value.
*3 : Predicted rate of change after 60 years at 20° C standard temperature.
(20% variation is considered in the rate of change)
*4 : The table shows examples of combinations.

Compressive Properties

Compressive stiffness K_V

● Compressive stiffness K_v is determined by the following equation.

$$K_V = E_C \cdot \frac{A}{H} \qquad E_C = \frac{E(1+2\kappa S_1^2)}{1+E(1+2\kappa S_1^2)/E_\infty}$$



Ultimate Compressive Stress (refer figure on the right)

● Critical stress σ_{cr} at zero shear strain is determined by the following equation.

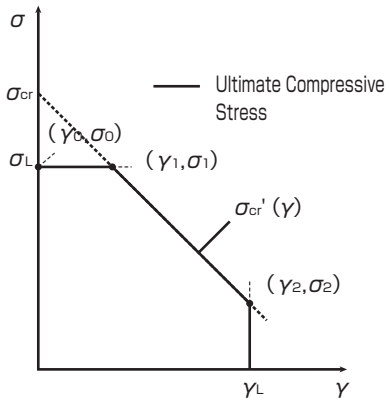
$$\sigma_{cr} = \pi/4 \cdot \alpha_c \cdot (G_{eq} \cdot E_b)^{0.5} \cdot S_2$$
Where, $E_b = E(1 + 2/3 \cdot \kappa \cdot S_1^2) / \{1 + E(1 + 2/3 \cdot \kappa \cdot S_1^2)/E_\infty\}$
α_c : Correction factor based on S_2 determined from our test data
if $S_2 \geqq 5$: $\alpha_c = 1.0$ if $S_2 < 5$: $\alpha_c = 0.10 \cdot (S_2 - 5) + 1$

● Ultimate compressive stress at any shear strain $\sigma_{cr}'(\gamma)$ is determined by σ_{cr} by the following equation.

$$\sigma_{cr}'(\gamma) = \sigma_{cr} \cdot (1 - \beta_c \cdot \gamma / S_2)$$
β_c : Correction factor based on S_2 determined from our test data
if $S_2 \geqq 5$: $\beta_c = 0.76$ if $S_2 < 5$: $\beta_c = 0.76/\{0.15 \cdot (S_2 - 5) + 1\}$

● The ultimate compressive stress shall not exceed the upper limit σ_L determined as below and the strain region corresponding to the ultimate strain γ_L at 0 compressive stress.

Rubber materials G0.30、G0.35 : $\sigma_L = 40$ (N/mm²)
Rubber materials G0.40、G0.45 : $\sigma_L = 60$ (N/mm²)
γ_L = min 400% S_2 × 100%

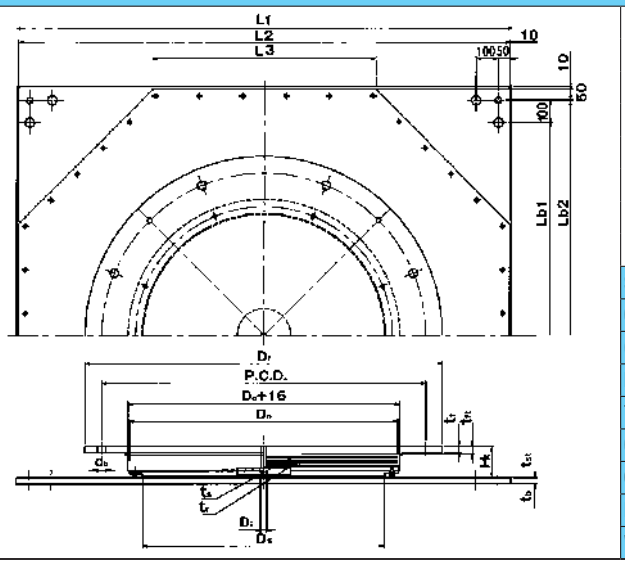


Elastic Sliding Bearing (1/2)

Seismic Isolation Material Certification Number by Ministry of Land, Infrastructure, Transport and Tourism
Evaluation Number for Revised Notification No. 1446

MVBR-0581 (ST Series, G4)
MVBR-0548 (SK Series, G4)
BCJ Evaluation-IB8004-01

Product Dimension

Characteristics		Sectional View
Physical Dimensions	Rubber outer diameter : D_0 (mm)	
	Rubber inner diameter : D_i (mm)	
	Effective diameter (outer diameter of sliding material) : D_s (mm)	
	Effective plane area : A ($\times 10^2 mm^2$)	
	Thickness of one rubber layer : t_r (mm)	
	Number of rubber layers : n	
	Total rubber thickness $H = n \cdot t_r$ (mm)	
	First shape factor $S_1 = (D_0 - D_i) / (4 \cdot t_r)$	
	Second shape factor $S_2 = D_0 / (n \cdot t_r)$	
	Flange diameter : D_f (mm)	
	Flange thickness: edge/center : t_f / t_{ft} (mm)	
	Connecting bolt hole P.C.D. : P.C.D. (mm)	
	Connecting bolt hole diameter × quantity : d_b (mm) × quantity	
	Bolt size (assumption) : M (d_b−3)	
	Thickness of each reinforcing steel plate : t_s (mm)	
	Total product height : H_t (mm)	
	Total product weight 1 (kN) = 1/9.80665 (tonf)	

Sliding plate
Outer dimension of base plate : L_1 (mm)
Outer dimension of SUS plate : L_2 (mm)
Inner dimension of SUS plate : L_3 (mm)
Total thickness : $t_s = t_b + t_{st}$ (mm)
Connecting bolt hole position : L_{b1},L_{b2} (mm)
Connecting bolt hole diameter x qty : d_b (mm) × qty
Bolt size (assumption) : M (d_b−5)
Weight of sliding plate : (kN)

Rubber Material

Rubber code (standard temperature: 20° C, standard strain γ = 100%)

Series	Rubber compound	Rubber code	Shear modulus G_{eq}(N/mm²)
ST, SK	G4	G0.4	0.392

Composition of rubber materials (weight ratio %)

Rubber code		Natural rubber Synthetic rubber	Filler, reinforcement agent	Vulcanizing agent & others
Inner Rubber	G0.4	60 and above	10 and above	25 and below
Cover Rubber		40 and above	15 and above	40 and above

Properties of rubber materials (some item names have been revised due to changes in JIS standards)

Item		Tensile strength (N/mm²)	Elongation at break (%)	Hardness	100% tensile stress (N/mm²)	Young's modulus E (N/mm²)	Bulk modulus E_∞ (N/mm²)	Correction factor κ due to rubber hardness
Test Standard		JIS K 6251	JIS K 6251	JIS K 6253	JIS K 6251	—	—	—
Inner Rubber	G0.4	17 and above	600 and above	37 ± 5	0.8 ± 0.2	2.20	1200	0.85
Cover Rubber		12 and above	600 and above	—	—	—	—	—

Sliding Material・Sliding Plate

Composition of sliding material and sliding plate (weight ratio %)

ST Series	Polytetrafluoroethylene	Filler
Sliding material	70 and above	30 and below

ST Series	Polytetrafluoroethylene	Filler
Sliding material	80	20
Sliding plate (SUS + coating)	55	45

Steel Material

Steel material for each part

		Material
Reinforcing steel plate*1		SS400 (JIS G 3101)
Flange*1		SS400 (JIS G 3101)
Sliding plate	Stainless plate	SUS304 (JIS G 4304) SUS316 (JIS G 4305)
	Base plate*1	SS400 (JIS G 3101)

*1 : JIS-compliant steel products (blast-furnace or electric-furnace steel) manufactured at JIS-certified plants in Japan or overseas are used.

Anti-corrosion treatment for flange and base plate

・ST Series / SK Series (except base plate)

Surface preparation	Degreasing (alkaline cleaning or organic solvent degreasing); oxide removal; and flux treatment
Galvanizing	JIS H 8641 HDZT 77*2
Coating thickness	JIS H 0401 coating thickness t≧77 (μm)

・SK Series (base plate only)

Surface preparation	Remove rust up to blasting quality of SSPC-SP – 10 (SIS Sa 2 1/2)
Primer	Zinc-rich paint 75 μm × 1 coat
Middle coat	Epoxy resin paint 60 μm × 1 coat
Finishing	Epoxy resin paint 35 μm × 1 coat
Total film thickness	170 μm and above

*2 : Due to the 2021 revision of the JIS standard, the designation was changed to HDZT 77. It corresponds to HDZ 55 under the previous standard.

Precautions

・For applications such as mid-story seismic isolation, fire-resistant cover is required. Please contact fire resistant cover manufacturer who are listed in the JSSI manufacturer list (https://www.jssi.or.jp/seismicisolation_maker) for more details.
・The ST Series cannot be installed in an inverted configuration (sliding plate on top). If inverted installation is required, please consider the SK Series. For the ST Series, the sliding plate and rubber bearing are delivered as an assembled unit.
・Some sliding plate sizes may be subject to transportation restrictions. Please contact Bridgestone for details.

Elastic Sliding Bearing (2/2)

Shear Properties

Initial stiffness K_1

Initial stiffness K1 of elastic sliding bearing is determined by the following equation

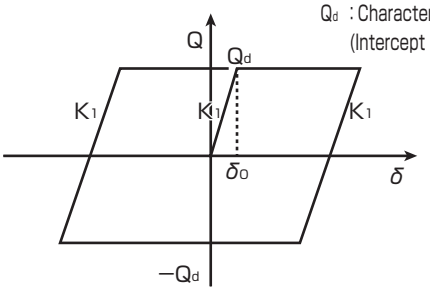
$$K_1 = \frac{G_{eq} \cdot A}{H}$$

Effective plane area A [mm²]
Total rebber thicknessH [mm]

Shear modulus G_{eq} in the above equation takes the values below.

	SK Series, ST Series
Shear modulus G_{eq} (N/mm²)	0.49

μ : Friction Coefficient
P_V : Vertical Load
K_1 : Initial Stiffness
δ : Horizontal Displacement
Q_d : Characteristic Strength (Intercept Load)



Friction coefficient μ

Compressive stress dependency and velocity dependency of the friction coefficient μ are determined by the following equations.

ST Series (μ 0.007, G0.4 Type)	SK Series (μ 0.010, G0.4 Type)
$\mu = 0.007 \times (\sigma/20)^{-0.8332} \times (V/400)^{0.0860}$	$\mu = 0.010 \times (\sigma/20)^{-0.51} \times (V/100)^{0.0894}$

σ [N/mm2] is the compressive stress applied on sliding material ; V [mm/s] is the sliding velocity
The standard velocity for SK Series is V = 100 [mm/s], for ST Series is V = 400 [mm/s]

Temperature dependency of initial stiffness

Initial stiffness shall be corrected to the value at standard temperature of 20° C by the following equations.
Applicable range: − 10° C ≤ T ≤ 40° C ; T : Temperature at the time of inspection (° C)

● Standard value of temperature dependency Standard temperature (20° C)*1

Properties		− 10℃	0℃	30℃	40℃
Initial stiffness K_1	ST Series, SK Series	Within + 8%	Within + 6%	Within − 3%	Within − 5%

*1 : The standard value takes into account the variation of 20% to the value obtained by the temperature correction equation.

Performance variation

The variation rates for the main factors affecting shear properties, including manufacturing variation, aging, and temperature effects, are shown below.

Series		ST Series		SK Series	
Properties		Initial stiffness K_1	Friction coefficient μ	Initial stiffness K_1	Friction coefficient μ
Manufacturing variation *2		Within ± 30%	Within ± 50%	Within ± 30%	Within ± 40%
Aging *3		Within + 10%	−	Within + 10%	−
Ambient temperature variation 20℃± 20℃	(+) side	Within + 6%	−	Within + 6%	−
	(−) side	Within − 5%	−	Within − 5%	−
Total	(+) side *4	Within + 46%	Within + 50%	Within + 46%	Within + 40%
	(−) side *4	Within − 35%	Within − 50%	Within − 35%	Within − 40%

*2 : The variation for both friction coefficient μ and initial stiffness K_1 of each product (standard value) shall be within the required variation range.
Reference: For compressive stiffness K_v, only individual product variation is controlled to be within ± 30% of the standard value.
*3 : Predicted rate of change after 60 years at 20° C standard temperature.
*4 : The table shows examples of combinations.

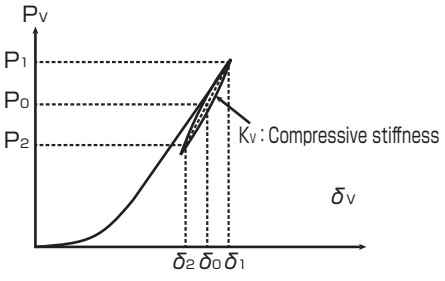
Compressive Properties

Compressvie stiffness K_V

● Compressive stiffness K_v is determined by the following equation.

$$K_V = \alpha_V \cdot E_C \cdot \frac{A}{H} \qquad E_C = \frac{E(1+2\kappa S_i^2)}{1+E(1+2\kappa S_i^2)/E_\infty}$$

(ST Series) α_V : 1.0 (SK Series) α_V : 0.85

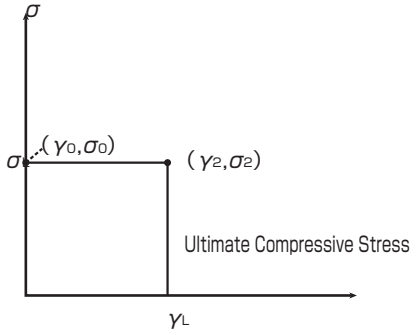


Ultimate Compressive Stress (refer figure on the right)

● Since bearings will slide before reaching to the buckling shear strain γ_L, ultimate compressive stress takes constant value as below regardless of the deformation of bearings.

For ST Series	$\sigma_L = 70$ (N/mm²)
For SK Series	$\sigma_L = 80$ (N/mm²)

● The ultimate deformation shall be determined by the relationship between bearing diameter and sliding plate dimension.
The upper limit is 1575mm for the ST Series and 1275mm for the SK Series,depending on the rubber bearing diameter



Others

Compact Flange Type

Features

Space-saving installation

The compact flange minimizes the required flange space, helping reduce installation space requirements. This also allows smaller footings for retrofit projects and installations near building edges.

Circular Rubber Section

The rubber section is circular, so shear properties are not affected by loading direction.

Applicable to a Wide Range of Seismic Isolation Rubber Bearings

The compact flange can be applied to any sizes from Bridgestone-certified seismic isolation rubber bearing products.

※ Compared with circular flanges, compact flanges have strength-related limitations. For details, please contact Bridgestone or your nearest Bridgestone sales company listed on the back cover.

Line-up

Line-up is for the flange-integrated seismic isolation bearing. Please contact Bridgestone for any size that isn't listed in the table below

Certification Number	Series	Size (rubber diameter)※1	Rubber Type	Shear & compressive properties
MVBR-0510/MVBR-0519※2 MVBR-0514/MVBR-0520※2	High Damping Rubber Bearing (Conventional Type)	φ600—φ1300	X4S X6R	Stiffness and other shear and compressive properties are equivalent regardless of flange shape.
MVBR-0650-1※3	High Damping Rubber Bearing (Flared Type)	φ600—φ1000	X4T※3	
MVBR-0509/MVBR-0518※2 MVBR-0295/MVBR-0540※2	Natural Rubber Bearing	φ600—φ1300	G4 N3,G3,G5	
MVBR-0517※2	Lead Rubber Bearing	φ600—φ1300	G4	

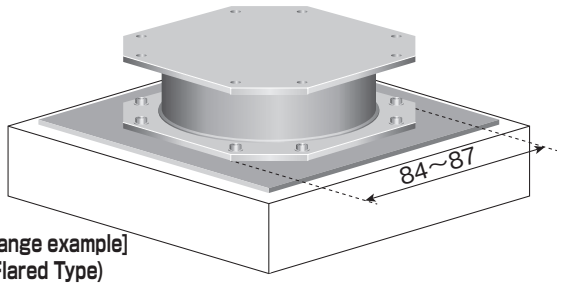
※1 : For φ 1400 and above, assembled type flange will be used.
※2 : For rubber diameters φ 600 to φ 750, the standard bolt hole diameter is φ 27 × 8 holes. For larger rubber diameters, the standard bolt hole diameter and number of holes are the same as those for circular flanges.
※3 : The flange has a square profile with rounded corners. The number of bolt holes is 12. Please contact Bridgestone for details.

Flange Size Table

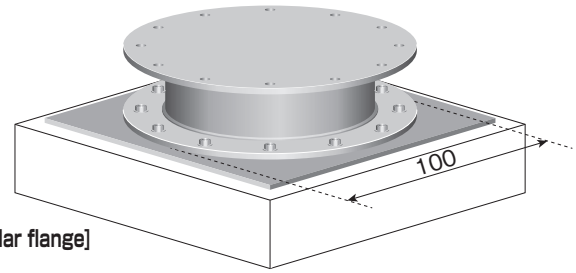
(Excluding Flared Type) (Unit : mm)

Rubber diameter	600	650	700	750	800	850	900	950	1000	1100	1200	1300
Circular flange diameter (D)	900	950	1000	1100	1150	1200	1250	1300	1400	1500	1600	1700
Side length of compact flange (L)	745	795	845	910	965	1010	1055	1100	1200	1290	1380	1470
D - L	155	155	155	190	185	190	195	200	200	210	220	230

—Comparison between Compact Flange Type and Circular Flange Type—

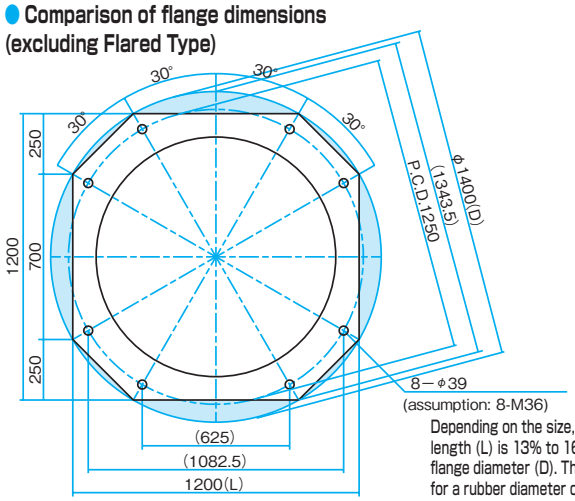


[Compact flange example]
(excluding Flared Type)



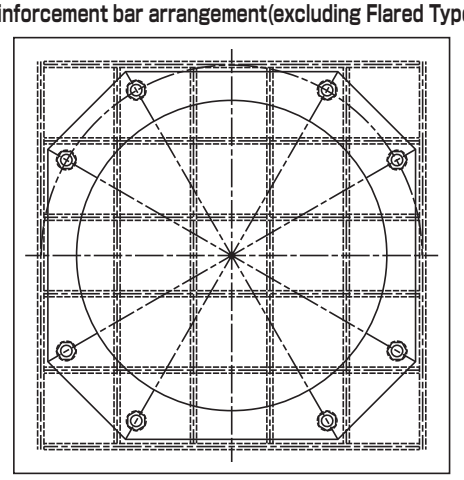
[Circular flange]

Comparison of flange dimensions (excluding Flared Type)



Depending on the size, the compact flange side length (L) is 13% to 16% smaller than the circular flange diameter (D). The figure shows an example for a rubber diameter of φ 1000.

View of reinforcement bar arrangement(excluding Flared Type)



View of reinforcement bar arrangement with span of 180-200mm.

Dustproof Cover SD for Elastic Sliding Bearing

Features

Excellent installation efficiency

The cover consists of 2.0 mm-thick polyvinyl chloride (PVC) and base fabric, allowing it to be rolled up and carried easily. This provides excellent installation efficiency and also allows easy removal during inspection and maintenance.

Flame resistance

With self-extinguishing properties, polyvinyl chloride can prevent the spread of fire in the event of fire.

Other features

During an earthquake, the Elastic Sliding Bearing and Dustproof Cover SD move together, so the cover does not affect seismic isolation performance.

Compared with the conventional product, the Dustproof Cover SD is more cost-effective and has a shorter lead time.

Dustproof

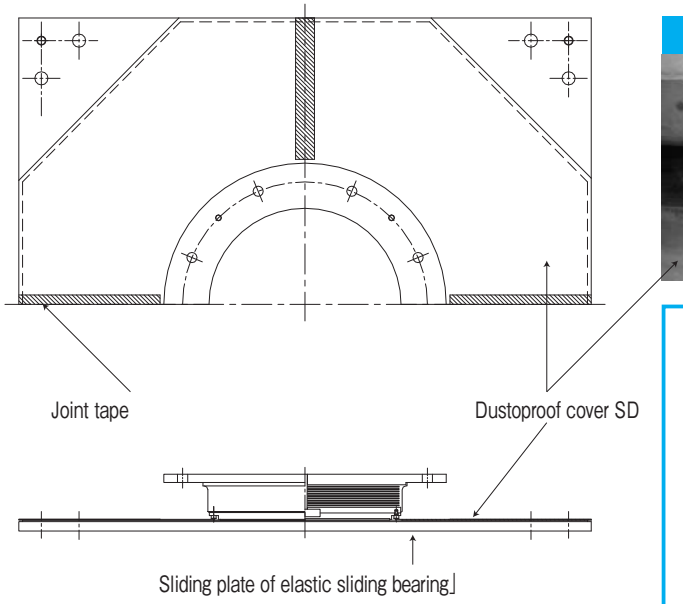
Dustproof Cover SD is installed to cover the entire sliding plate surface without gaps, helping prevent dust and debris from accumulating on the surface.

Durability

Polyvinyl chloride offers excellent durability with minimal strength degradation, allowing long-term use with confidence.

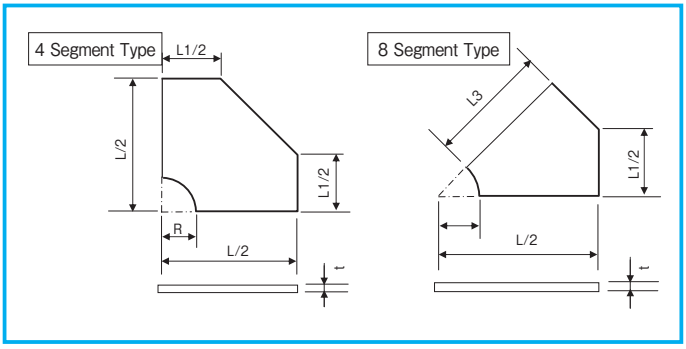
Precaution

Since the cover is made of Polyvinyl chloride, high-temperature treatment is required for disposal.



Example of installation





The table below provides typical examples. The applicable dustproof cover model differs depending on the limit deformation.
For other sizes, please contact Bridgestone or your nearest Bridgestone Group company.

Applicable bearing diameter	Model Number	L (mm)	R (mm)	L1 (mm)	L2 (mm)	L3 (mm)※	Number of segments	T (mm)	Weight (kg/set)
For ϕ 300	SD132291	1320	145	570	375		4	2	4.2
For ϕ 400	SD142381	1420	190	620	400		4	2	4.7
For ϕ 500	SD152471	1520	235	670	425		4	2	5.3
For ϕ 600	SD162561	1620	280	720	450		4	2	5.9
For ϕ 700	SD172651	1720	325	770	475		4	2	6.5
For ϕ 800	SD182741	1820	370	820	500		4	2	7.1
For ϕ 900	SD192831	1920	415	870	525		4	2	7.8
For ϕ 1000	SD202921	2020	460	920	550		4	2	8.4
For ϕ 1100	SD212X11	2120	505	970	575		4	2	9.1
For ϕ 1200	SD222Y01	2220	550	1020	600		4	2	9.8
For ϕ 1300	SD232A21	2320	660	1070	625	539	8	2	9.7
For ϕ 1400	SD242B21	2420	710	1120	650	542	8	2	10.3
For ϕ 1500	SD252C21	2520	760	1170	675	565	8	2	10.9

※ L3 applies only to the 8-segment type.

Precautions for Safe Use of Seismic Isolation Bearing (SIB) for Buildings

This section provides precautions for the safe use of seismic isolation bearings (SIB), including High Damping Rubber Bearings, Lead Rubber Bearings, Natural Rubber Bearings, and Elastic Sliding Bearings. For clarity, "SIB" is used in this section as a collective term for these products.

An Elastic Sliding Bearing consists of two components: the elastic bearing unit and the sliding plate. The following terminology is used in this section:

- Elastic Sliding Bearing: Complete assembly consisting of the elastic bearing unit and sliding plate
- Elastic bearing unit / Sliding plate: Individual components of the Elastic Sliding Bearing

⚠ WARNING Failure to follow these precautions may result in death or serious injury.

- Transport SIB one unit or one set at a time. Transporting multiple units or sets at the same time may cause instability due to the product weight, resulting in falling or overturning.
- When lifting SIB with a crane or similar equipment, use a crane and lifting devices, such as eyebolts, suitable for the product weight. Improper lifting may cause instability, resulting in falling or overturning.
- Before lifting SIB with a crane or similar equipment, confirm that the surrounding area is safe and keep all personnel clear of the lifting area. Falling or overturning of heavy SIB may result in death or serious injury.
- The elastic bearing unit and sliding plate may be packaged separately due to sling load limits or strength considerations. In such cases, transport and lift each packaged unit individually.
- The rubber of SIB are combustible. Keep open flames away from SIB, and do not perform welding on the flange or sliding plate. Ignition of SIB may result in fire, product damage, or burn injury.

NOTICE Failure to follow these precautions may result in reduced SIB performance or premature loss of durability.

○ Precautions during building design

- Use SIB only in environments where the minimum and maximum air temperatures are within -10° C to 40° C, and the annual average temperature is within 5° C to 30° C.
- The allowable compressive stress range is specified for each rubber type. Use SIB so that the long-term compressive load, or long-term compressive stress, remains within the specified range.
- Use SIB in locations where the product is not exposed to direct sunlight.
- Do not use SIB in locations where the product may be exposed to water or condensation.

○ Precautions during construction

- Do not apply large impact (falling, collision, etc.) to SIB. Damaged SIB may cause function deterioration of the SIB and an early deterioration in durability.
- Do not roll the SIB or twist it with iron lever or bar. Damaged SIB may cause function deterioration and an early deterioration in durability.
- Be careful not to damage the SIB with other equipment (such as a cutter when packaging removal). Damaged SIB may cause function deterioration of the SIB and an early deterioration in durability.
- Do not expose the SIB to a temporary high temperature condition (about 100° C or higher). Due to the influence of heat, the rubber part of the SIB may be damaged, which may cause function deterioration of the SIB and an early deterioration in durability.
- In principle, Elastic Sliding Bearings should be stored indoors. For the ST type, lubricant is applied between the elastic bearing unit and sliding plate. During construction, avoid separating the elastic bearing unit from the sliding plate. If outdoor storage is unavoidable, provide appropriate rain protection and prevent rainwater from entering the sliding interface.

NOTICE Failure to follow these precautions may result in reduced SIB performance or premature loss of durability.

- When tightening the bolt in SIB installation work, do not damage the flange antirust coating part with bolt /washer fastening jig or others. It may cause an early deterioration in durability to the flange antirust coating part.
- Install SIB so that the bottom surface levelness is within 1/400 and the product inclination is within 1/200. Excessive inclination may prevent SIB from functioning properly and may impair its performance. The bottom surface levelness requirement above is also stated in the MLIT Seismic Isolation Material Certification.
- Temporary fixing brackets for Elastic Sliding Bearings may shift due to vibration during transportation. These brackets are intended only for temporary fixing during transportation and are not designed for use during construction. Remove them promptly after installation.
- Do not apply or adhere oils, solvents etc. to the rubber part. Due to deterioration, dissolution etc. of the rubber part may cause function deterioration of the SIB and premature loss of durability.
- If the residual displacement after the earthquake is equal to or greater than the preset displacement (approximately 5 cm as a guideline), promptly take measures to restore it to the origin.
- If tension, uplift, gaps, or product inclination of 1/200 or greater is found in SIB at completion of construction, promptly take corrective action.
- Carry out appropriate maintenance as specified in the design documents (completion inspection by a certified specialist). Confirm that no conditions have occurred that could impair SIB performance or cause premature loss of durability.
- After SIB installation, provide adequate ventilation in the seismic isolation interface and promptly remove any water caused by rainwater, condensation, or similar sources. Failure to do so may reduce performance and cause premature deterioration of the anti-corrosion coating or plating on the flanges.
- Do not allow SIB to become submerged. Water may penetrate SIB and adversely affect its performance.
- Chemicals contained in water or deposits, including those from flooding, may cause rubber deterioration or dissolution, or corrosion of the flanges. If flooding occurs, promptly drain the water. In all cases, remove moisture, deposits, and chemicals, then clean and dry the affected areas.
- For Elastic Sliding Bearings, water entering the sliding interface may change the friction coefficient and impair its performance. Repair or replacement may be required.
- Avoid applying misalignment, torsion, or tensile force to SIB. Partial damage or deformation may occur. If large construction loads are expected, restraint measures are recommended to prevent deformation of SIB.
- When welding near SIB, cover SIB with fire-protection sheets to prevent welding sparks from directly contacting the product. Welding sparks may melt the resin coating on the sliding plate (SK Series only), burn the rubber of SIB, or cause ignition.
- The sliding plate uses a stainless steel plate (for the SK Series Elastic Sliding Bearing, it uses a resin-coated stainless steel plate), which includes areas that can be easily damaged. Provide protective covering to prevent damage and observe the following precautions. If the product is delivered with protective covering applied by Bridgestone, observe the following precautions to prevent damage:
  - ※ Do not install temporary supports, place heavy objects, or step on the protective covering.
  - ※ Do not drive nails into the protective covering or use cutters on the protective covering.
- Elastic Sliding Bearings have a low product height. Check the full length of the mounting bolts to avoid interference during replacement.
- When removing restraints fixed to the flange or sliding plate tapped holes after construction, install bolt caps for the tapped holes. If bolt caps are not installed, water may remain in the tapped holes, causing rust or premature deterioration of the anti-corrosion coating (or anti-corrosion plating).
- If scratches or peeling are found on the anti-corrosion coating (or anti-corrosion plating) of the flange after construction, apply touch-up coating. The anti-corrosion coating (or anti-corrosion plating) consists of a thin resin or zinc film, and minor scratches may occur when tools or similar items contact the surface. Water entering scratched areas may cause rust or peeling and may lead to premature deterioration of the anti-corrosion coating (or anti-corrosion plating).
- After construction, installation of a dust cover on the sliding plate is recommended, except when the product is delivered with a dust cover. Avoid damaging the sliding plate with foreign objects adhering to the surface.
- If adhesive materials, such as adhesive tape or bonding agents, are applied to the flange or similar steel components of SIB or to the sliding plate surface, chemical reactions may cause damage (swelling or peeling) or contamination.

NOTICE Failure to follow these precautions may result in reduced SIB performance or premature loss of durability.

○ Precautions after construction completion and during building operation

• SIB is not intended for use in highly humid or wet environments. Environments where SIB may become wet due to rainwater, groundwater, or condensation, environments with frequent wet-dry cycles, or environments exposed to direct sunlight may cause premature deterioration of the anti-corrosion coating (or anti-corrosion plating). Water entering the sliding interface of an Elastic Sliding Bearing may change the friction coefficient, reduce performance, and require repair or replacement.

• Provide adequate airflow and ventilation in the seismic isolation interface, and promptly remove any moisture caused by condensation.

• If scratches, peeling, blistering, rust, or similar defects are found on the anti-corrosion coating (or anti-corrosion plating), leaving them untreated may reduce the shear properties of SIB and cause premature deterioration of anti-corrosion durability. If the affected area is near the rubber portion (within 1 cm from the edge), early repair is recommended, preferably within the following year. For other areas, establish and carry out a long-term maintenance plan.

• To maintain anti-corrosion performance, regular maintenance of the anti-corrosion coating (or anti-corrosion plating) on the flanges is recommended. Depending on the installation environment, maintenance is often performed approximately every 3 to 7 years.

• Do not allow SIB to become submerged. Water may penetrate SIB and adversely affect its performance.

• Chemicals contained in moisture or deposits, including cases other than flooding, may cause rubber deterioration or dissolution, or corrosion of the flanges. If flooding occurs, drain the water promptly. In all cases, remove moisture, deposits, and chemicals, then clean and dry the affected areas.

• If SIB is installed underground, abnormal groundwater rise or rainwater inflow during localized heavy rainfall may cause flooding. Regularly check the condition of the seismic isolation interface.

• Do not apply grease, oil, solvents, or similar substances to the rubber of SIB, and do not allow these substances to adhere to the rubber of SIB. These substances may cause rubber deterioration or dissolution.

• If residual displacement after an earthquake is equal to or greater than the specified displacement (approximately 5 cm as a guideline), promptly restore SIB to its original position.

• Carry out appropriate maintenance as specified in the design documents, including inspections by specialists (routine inspection, periodic inspection, emergency inspection, detailed inspection, etc.). Regular checks are required to confirm that no conditions have occurred that may impair SIB performance or cause premature loss of durability.

• If adhesive materials, such as adhesive tape or bonding agents, are applied to the flange or similar steel components of SIB, or to the sliding plate surface, chemical reactions may cause damage (swelling or peeling) or contamination.

○ Maintenance inspection after construction completion

Appropriate maintenance shall be carried out in accordance with the 「Maintenance Plan」 specified in the project design documents or the 「Maintenance Standards for Seismically Isolated Buildings」 issued by the Japan Society of Seismic Isolation (JSSI).

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