BRIDGESTONE
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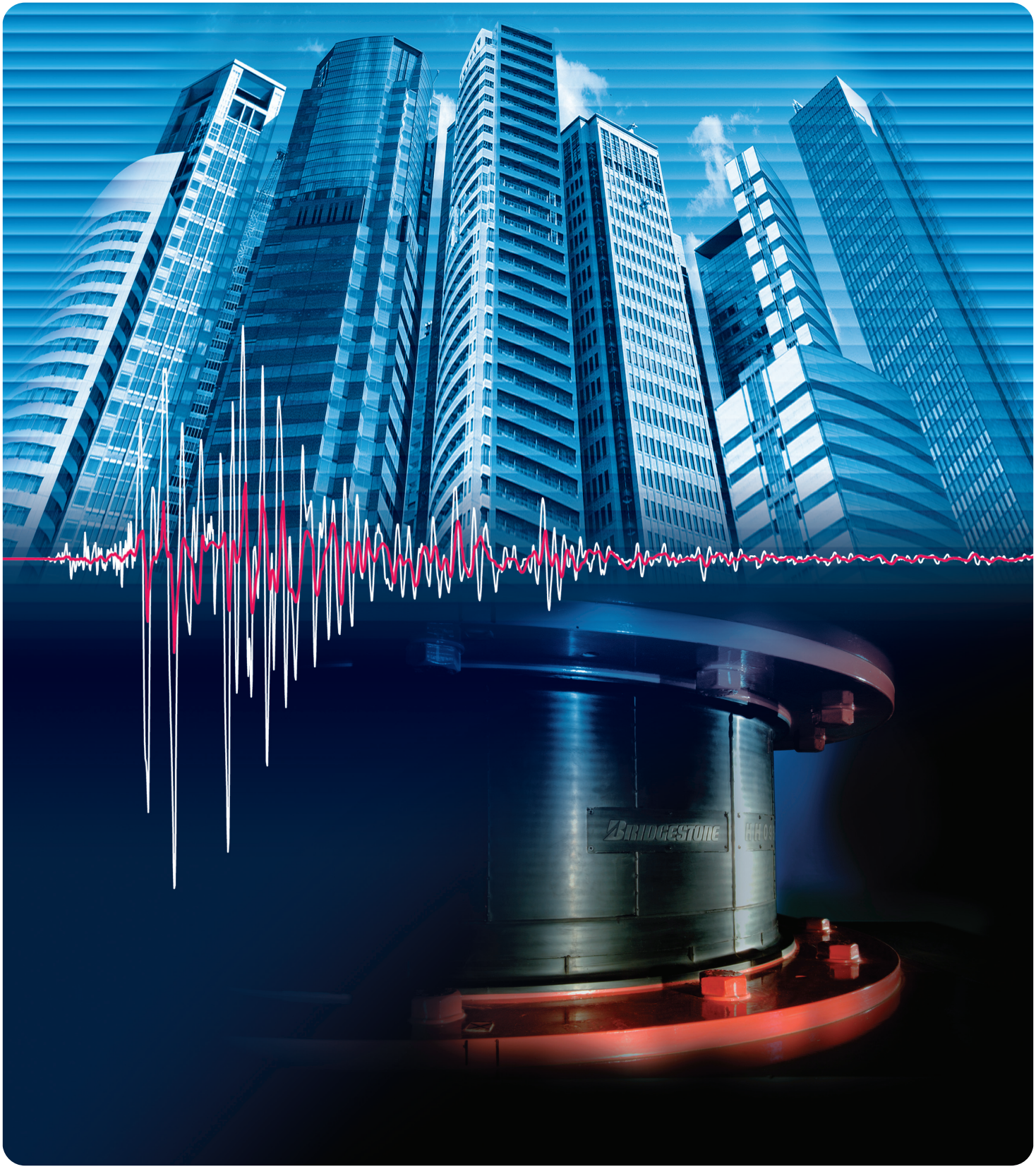
# Seismic isolation product line-up

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

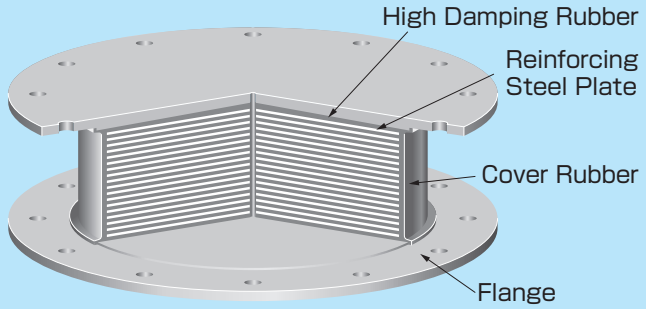


# Bridgestone seismic isolation product line-up

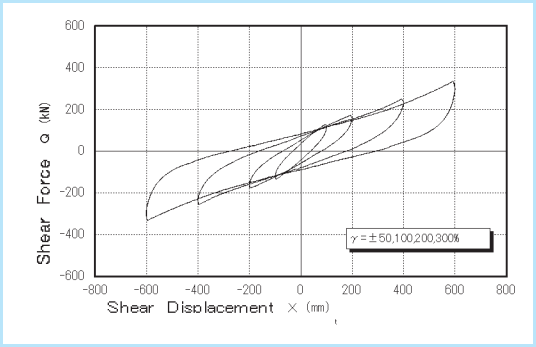
We will meet the customer needs with our new product line-up .

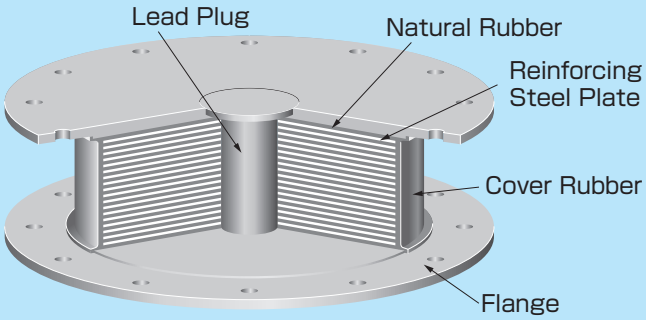
| | Page | Features |
|---|---|---|
| **HDR**<br>High Damping Rubber Bearing | (Description)<br>p5-p7<br>(Product Specifications)<br>p16-p21<br>●<br>HH series<br>(Total rubber thickness 20cm type)<br>HL series<br>(Total rubber thickness 16cm type)<br>HT series<br>(Total rubber thickness 25cm type) | High damping rubber includes both spring and damping characteristics. Generally, a separate damper is not required, making it an excellent choice for areas with space constraints.<br>Since its hysteresis curves are relatively smooth, seismic isolation can also be extended to in-equipment inside the building.<br>Two different elastic moduli are available (E0.4, X0.6R). Light column loads can also be accommodated. |
| **LRB**<br>Lead Rubber Bearing | (Description)<br>p8-p10<br>(Product Specifications)<br>p22-p32<br>●<br>LH series<br>(Total rubber thickness 20cm type)<br>LL series<br>(Total rubber thickness 16cm type)<br>LT series<br>(Total rubber thickness 25cm type)<br>LS series<br>(S2=5 type) | This bearing includes a lead plug embedded at the centre of a laminated natural rubber structure, where the rubber incorporates the spring capability and the lead plug provides the damping capability.<br>Generally, a separate damper is not required making it a good choice for areas with space constraints. Its hysteresis resembles elasto-plastic materials. The attenuation can be tuned by varying the lead plug diameter. One type of rubber material is available (G0.40). |
| **NRB**<br>Natural Rubber Bearing | (Description)<br>p11-p12<br>(Product Specifications)<br>p33-p41<br>●<br>NS series<br>(S2=5 type)<br>NH series<br>(Total rubber thickness 20cm type)<br>NL series<br>(Total rubber thickness 16cm type)<br>NT series<br>(Total rubber thickness 25cm type) | This bearing uses natural rubber, which inherently has a low damping factor (about 2~3% equivalent damping factor), excellent linearity, and a stable restoring force.<br>A separate damper is required, but the overall isolation design has much greater flexibility. Four different kinds of elastic moduli are available (G0.30,G0.35,G0.40, G0.45) to support a wide range of column loads. |
| **Elastic Sliding Bearing** | (Description)<br>p13-p15<br>(Product Specifications)<br>p42<br>●<br>SP series<br>( $\mu$ =0.015, G0.4 type)<br>SK series<br>( $\mu$ ==0.011, G0.4 type)<br>SL series<br>( $\mu$ =0.13, G1.2 type) | This bearing consists of 2 pieces: 1) a natural rubber bearing bonded with PTFE (Teflon) material and; 2) a stainless steel slide plate. Small displacements are absorbed by the rubber itself, while large displacements cause the rubber bearing to slide on the plate. Since there is no restoring force, the slide bearing is normally used in combination with NRB, LRB or HDR.<br>Three different coefficients of friction are available to suit the damping requirements. |

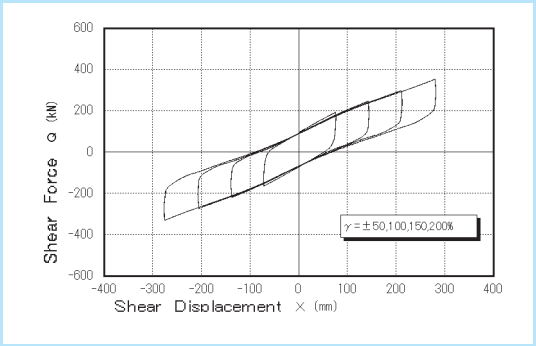
## Sectional View

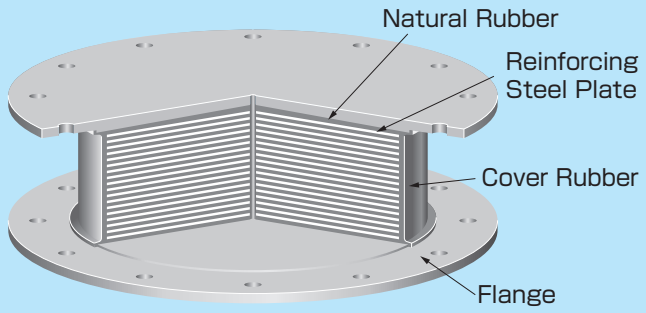


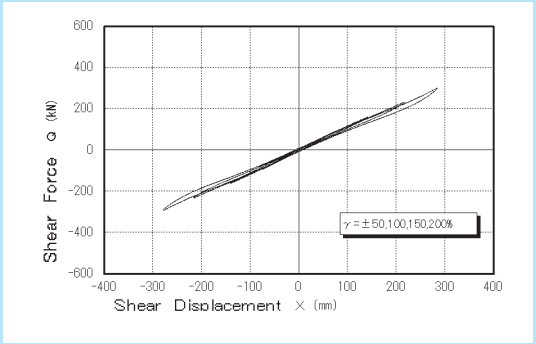

## Hysteretic Loop

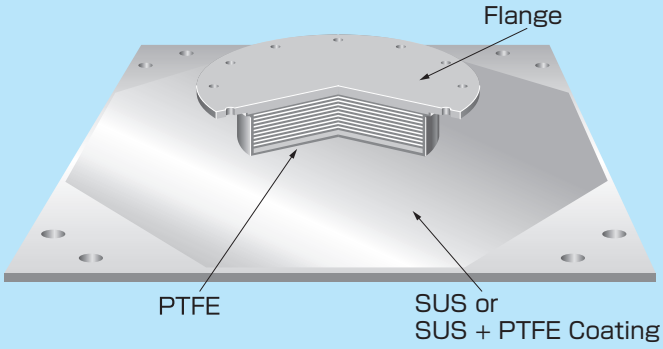


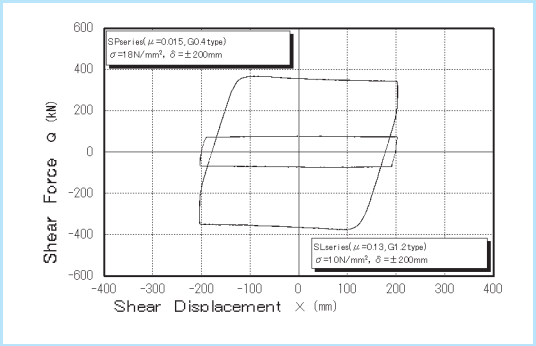




Note: The above diagram and hysteristic loop are for illustrative purpose only.

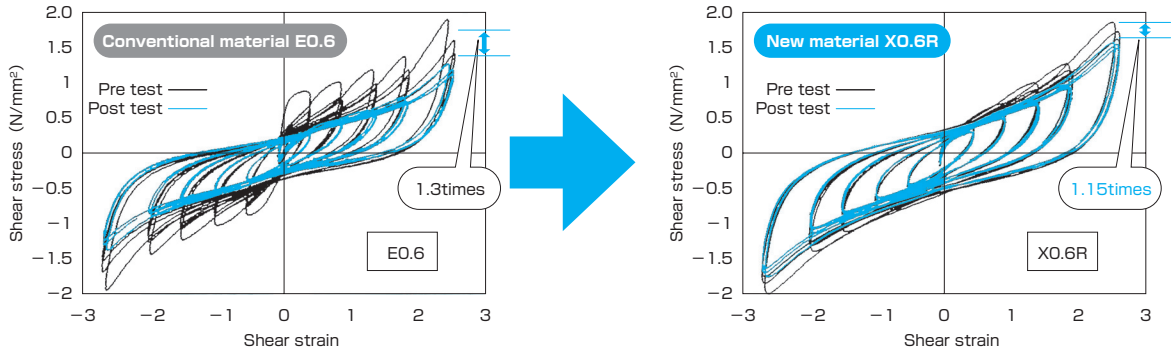
Bridgestone advanced polymer technology created the next-generation high damping rubber.

# High damping rubber bearing series X0.6R

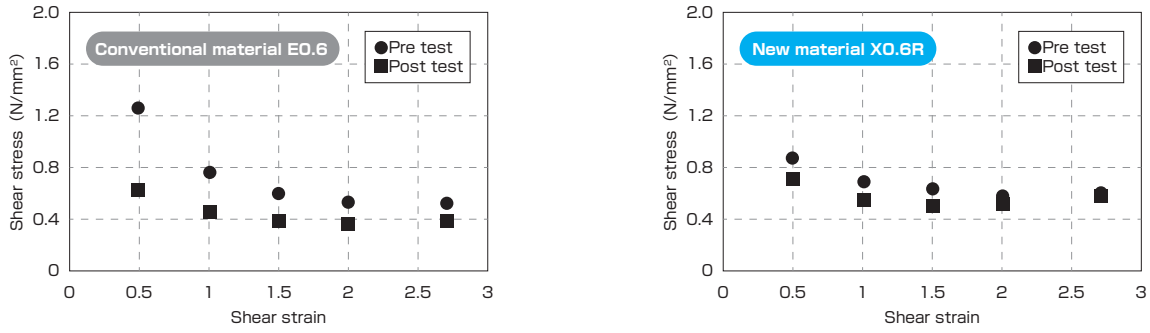
## Features of high damping rubber bearing series X0.6R

A 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 elements and is widely adopted as a seismic isolator.
However, the traditional 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 X0.6R, 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 properaties caused by bi-directional loading.

## ● Reduction in loading hysteresis dependency



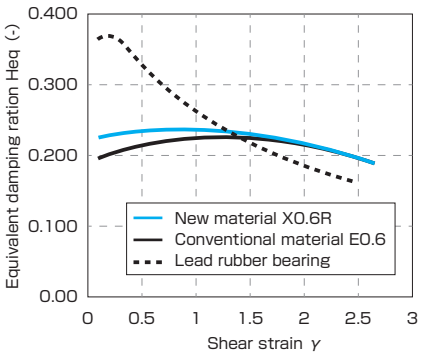

Compared to conventional high damping rubber, the change of equivalent shear stiffness (1cycle/3cycle) in repeated loading is reduced (1.30 → below 1.15 ). The properties of seismic isolation rubber bearings are defined by the 3rd cycle. The result is a bearing that reduces the load variation during initial deformation.




Traditional 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 analysis of a high damping rubber bearing system can be easily managed and the accuracy of the overall seismic isolation design can be improved.

## ● Increasing of equivalent damping ratio

Compared to traditional high damping rubber, the equivalent damping ratio (at shear strain $\gamma = \pm 100\%$) of high damping rubber X0.6R is increased (0.225 → 0.240). In addition, a higher damping ratio can be obtained in the range of $\gamma \leqq 170\%$, while maintaining the same value in the range of $\gamma \geqq 170\%$ shear strain, as compared to traditional high damping rubber. Furthermore, compared to the same diameter of lead rubber bearing (lead diameter / outer diameter = 0.2), a higher damping ratio can be obtained in the range of $\gamma \geqq 130\%$ for high damping rubber X0.6R.



# Ultimate Properties of High Damping Rubber Bearings by Horizontal Bi-directional Loading

## ● Outline

The ultimate deformation of high-damping rubber is degraded by applying bi-directional loading compared to unidirectional loading. Through the use of a horizontal bi -directional loading test, with a full scale model high-damping rubber bearing, torsional deformation can be seen in the side view of the rubber. Compared with unidirectional loading, the phenomenon of breaking at early stage by bi-directional loading has been identified. The standard value of the ultimate properties, influenced by bi-directional loading, is shown below and the ultimate compressive stress is confirmed.

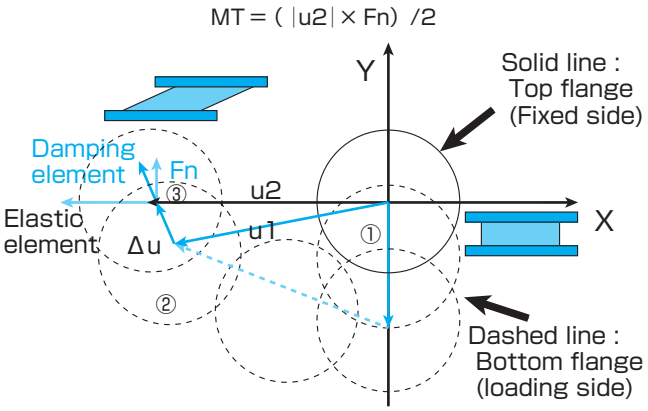



Figure 1: The mechanism of torsional deformation

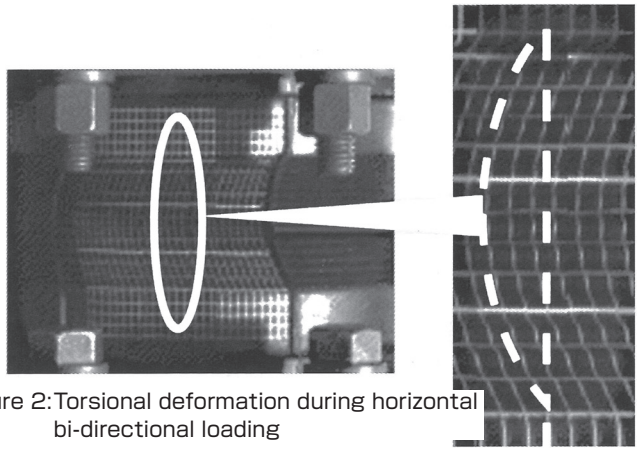


Figure 2:Torsional deformation during horizontal bi-directional loading

As shown in Figure 1, when the bi-directional loading is applied on a high damping rubber bearing, the elastic force occurs in the shear deformation direction, while the damping force occurs in the tangential direction of the deformation trajectory. The torsional moment created by the damping elements and the shear deformation is present at each rubber layer of the laminated structure. The additional shear strain $\gamma_\phi$ caused by torsional deformation is added to the shear strain caused by the rubber shear deformation itself. Thus, it will rupture relatively early compared to the unidirectional loading test.
However, the torsional deformation caused by bi-directional loading does not affect the buckling ultimate strain, as verified experimentally.

## ● Ultimate Property of Horizontal Bi-directional Loading

According to the Japan Society of Seismic Isolation (JSSI) guidelines, the final ultimate strain is determined by the minimum of the ultimate strain $\gamma_L$ by unidirectional loading and the ultimate strain $\gamma_{Bo}$ by bi-directional loading.

● Ultimate strain by unidirectional loading
Ultimate strain by unidirectional loading is defined as shown in Table 1.

Table 1: Standard value of ultimate strain by unidirectional loading

| Compound | Ultimate strain $\gamma_L$ by unidirectional loading |
|---|---|
| XO.4R | $0.9 \times S_2 \times 100$ $(0.9 \times S_2 < 4)$<br>400% $(0.9 \times S_2 \geqq 4)$ |
| XO.6R | $0.9 \times S_2 \times 100$ $(S_2 < 4.5)$<br>400% $(S_2 \geqq 4.5)$ |

$S_2$ : Second shape factor

● Ultimate strain by bi-directional loading
Ultimate strain by bi-directional loading is defined as shown in Table 2.

Table 2: Standard value of ultimate strain by bi-directional loading

| Compound | Formula of ultimate strain $\gamma_{Bo}$ by bi-directional loading |
|---|---|
| XO.4R | $\gamma_{BO} = (5.80 \times S_2 + 9.05) / (S_2 + 4.49)$ |
| XO.6R | $\gamma_{BO} = (5.00 \times S_2 + 9.05) / (S_2 + 4.49)$ |

$S_2$ : Second shape factor

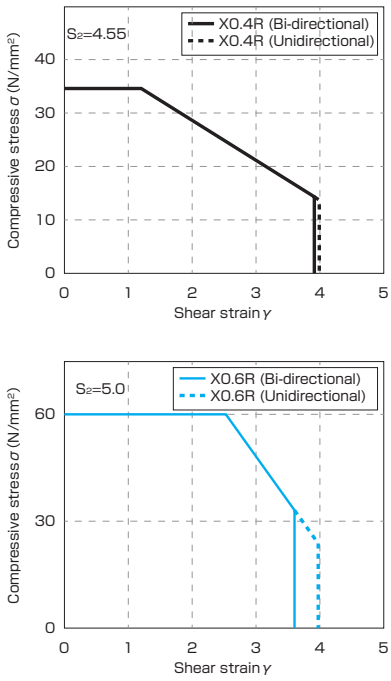



Figure 3:Comparison example of ultimate property diagram

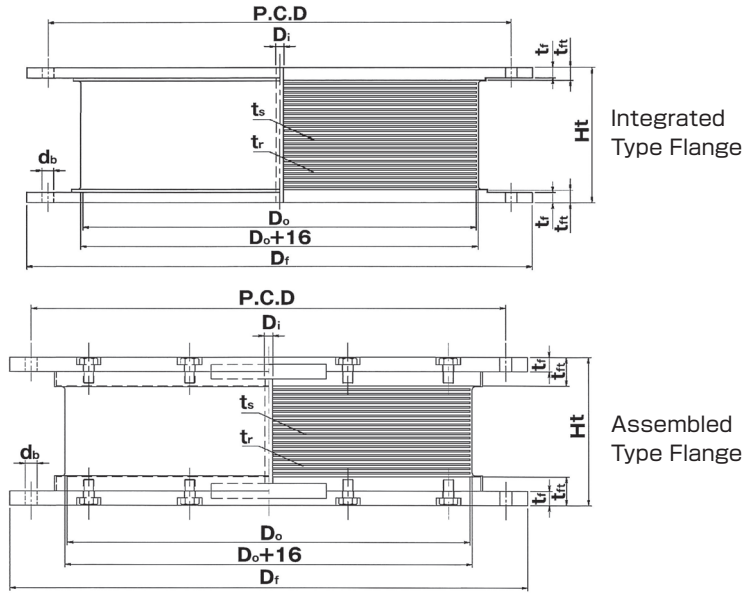
# Product Specification & Description of Performance Characteristics

## High Damping Rubber Bearing (HDR)

Seismic isolation material certification number by Ministry of Land, Infrastructure and Transport

MVBR-0468 (X 0.4R) Acquired in December 2012
MVBR-0430 (X 0.6R) Acquired in February 2011

## ● Product Dimension

| Item | | Description |
|---|---|---|
| Shape & dimensions of each part | Outer diameter : $D_o$ (mm) |  |
| | Inner diameter : $D_i$ (mm) | |
| | Effective plane area : A ($\times 10^2 mm^2$) | |
| | Thickness of each rubber layer : $t_r$ (mm) | |
| | Number of rubber layers : n | |
| | Total rubber thickness : $H = n \times t_r$ (mm) | |
| | First shape factor $S_1 = (D_o - D_i) / (4 \times t_r)$ | |
| | Second shape factor $S_2 = D_o / (n \times t_r)$ | |
| | Diameter of flange : $D_f$ (mm) | |
| | Thickness of flange: edge/center : $t_f/t_{ft}$ (mm) | |
| | Connecting bolt PCD : PCD (mm) | |
| | Diameter of connecting bolt hole x qty : $d_b$ (mm) x qty | |
| | Bolt size (assumption) : M ($d_b$−3) | |
| | Thickness of each reinforced steel plate : $t_s$ (mm) | |
| | Total height : $H_t$ (mm) | |
| | Total weight 1 (kN) = 1/9.80665 (tonf) | |



## ● Rubber Material

Rubber code
(standard temperature 20℃ , standard strain y = 100%)

| Rubber code | Shear modulus $G_{eq}$ ($N/mm^2$) | Equivalent damping ratio $H_{eq}$ |
|---|---|---|
| X0.4R | 0.392 | 0.220 |
| X0.6R | 0.620 | 0.240 |

Combination of rubber materials
(weight ratio %)

| Rubber designation | | Natural rubber Synthetic rubber | Reinforcementagent, Filler | Vulcanization agent and others |
|---|---|---|---|---|
| Rubber layers | X0.4R | 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

| Item | | Tensile strength ($N/mm^2$) | Elongation at Break (%) | Hardness (JIS A) | 100% modulus ($N/mm^2$) | Young's modulus E ($N/mm^2$) | Bulk modulus $E_\infty$ ($N/mm^2$) | Young's modulus correctionfactor according to hardness |
|---|---|---|---|---|---|---|---|---|
| Test Standard | | JIS K6251 | JIS K6251 | JIS K6253 | JIS K6251 | | | |
| Inner rubber | X0.4R | 7 以上 | 840 以上 | 37 ± 8 | 0.43 ± 0.2 | 6.2 | 1300 | 1.0 |
| | X0.6R | 8.5 以上 | 780 以上 | 53 ± 5 | 0.73 ± 0.2 | 7.6 | 1500 | 1.0 |
| Cover rubber | | 12 以上 | 600 以上 | – | – | | | |

## ● Steel Material

Each steel part

| | Material |
|---|---|
| Reinforced steel plate | SS400 (JIS G 3101) |
| Flange plate *1 | SS400 (JIS G 3101) |
| Connecting plate *1 | SS400 (JIS G 3101) |

*1:Optionally SM490 (JIS G 3106).

Anti-rust treatment of flange plate

| | |
|---|---|
| Preparation | Remove rust up to blasting quality of SSPC-SP-10 (SIS Sa 2 1/2) |
| Primer | Zinc-rich paint 75 μ m x 1 coat |
| Middle coat | Epoxy resin paint 60 μ m x 1 coat |
| Finishing | Epoxy resin paint 35 μ m x 1 coat |
| Total film thickness | 170 μ m and above |

*1:Standard color is gray.
*2:Others anti-rust treatment of flange plate than painting are also available. Please contact us for more details.

# ● Shear Properties

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

Shear properties of HDR is dependent on shear strain amplitude.
The shear strain dependency of each property is expressed by following equations.

● Rubber Material X0.4R $(0.1 \leqq \gamma \leqq 2.7)$

$$G_{eq}(\gamma) = 0.054\times\gamma^4 - 0.416\times\gamma^3 + 1.192\times\gamma^2 - 1.583\times\gamma + 1.145$$
$$H_{eq}(\gamma) = -0.006\times\gamma^3 + 0.018\times\gamma^2 - 0.008\times\gamma + 0.216$$
$$u(\gamma) = -0.0110\times\gamma^3 + 0.0325\times\gamma^2 - 0.0132\times\gamma + 0.3617$$

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

$$G_{eq} = G_0 \times (2.855 - 3.878\gamma + 2.903\gamma^2 - 1.016\gamma^3 + 0.1364\gamma^4)$$

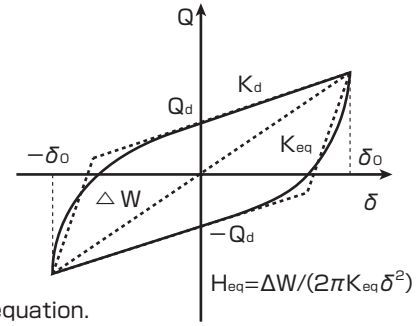
$G_0 = 0.620$; shear modulus at $\gamma = 1.0$

$$H_{eq} = H_{eq0} \times (0.9150 + 0.2364\gamma - 0.1804\gamma^2 + 0.02902\gamma^3)$$

$H_{eq0} = 0.240$; equivalent damping ratio at $\gamma = 1.0$

$$u = u_0 \times (0.9028 + 0.2711\gamma - 0.2083\gamma^2 + 0.03421\gamma^3)$$

$u_0 = 0.408$; function giving ratio of characteristic strength to maximum shear force of a loop at $\gamma = 1.0$




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

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 : $K_1 = 10 \times K_2$
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 is corrected to the value at standard temperature of 20℃ by following equations.
(Applicable range: − 10 ≦ T ≦ 40℃ ) (T: Temperature during inspection)

● Rubber Material X0.4R :
$$K_{eq}(\text{corrected value at } 20℃) = K_{eq}(T℃)/(1.205 - 1.862\times10^{-2}\cdot T + 5.991\times10^{-4}T^2 - 8.991\times10^{-6}T^3)$$
$$H_{eq}(\text{corrected value at } 20℃) = H_{eq}(T℃)/(1.065 - 4.134\times10^{-3}\cdot T + 1.096\times10^{-4}T^2 - 3.102\times10^{-6}T^3)$$

● Rubber Material X0.6R :
$$K_{eq}(\text{corrected value at } 20℃) = K_{eq}(T℃)/(1.205 - 1.862\times10^{-2}\cdot T + 5.991\times10^{-4}\cdot T^2 - 8.991\times10^{-6}\cdot T^3)$$
$$H_{eq}(\text{corrected value at } 20℃) = H_{eq}(T℃)/(1.065 - 4.134\times10^{-3}\cdot T + 1.096\times10^{-4}\cdot T^2 - 3.102\times10^{-6}\cdot T^3)$$

● Standard value of temperature dependency Standard temperature (20℃ )

| Properties values | | − 10℃ | 0℃ | 30℃ | 40℃ |
|---|---|---|---|---|---|
| X0.4R | Equivalent shear stiffness $K_{eq}$ | within + 46% | within + 21% | within − 6% | within − 16% |
| | Equivalent damping ratio $H_{eq}$ | within + 12% | within + 7% | within − 4% | within − 12% |
| X0.6R | Equivalent shear stiffness $K_{eq}$ | within + 46% | within + 21% | within − 6% | within − 16% |
| | Equivalent damping ratio $H_{eq}$ | within + 12% | within + 7% | within − 5% | within − 13% |

## ■ Performance variation

The rate of change of main causes (manufacturing variation, aging, temperature change) which affect shear properties shall be shown as below.

| Rubber materials | | X0.4R | | X0.6R | |
|---|---|---|---|---|---|
| | | Equivalent shear stiffness $K_{eq}$ | Equivalent damping ratio, $H_{eq}$ Function giving ratio of characteristic strength to maximum shear force, u | Equivalent shear stiffness $K_{eq}$ | Equivalent damping ratio, $H_{eq}$ Function giving ratio of characteristic strength to maximum shear force, u |
| Manufacturing variation *1 | | ± 10% | ∓ 10% | ± 10% | ∓ 10% |
| Aging *2 | | + 10% | − 10% | + 10% | − 10% |
| Ambient temperature variation 20℃± 20℃ | (+)side | + 21% | + 7% | + 21% | + 7% |
| | (−)side | − 16% | − 12% | − 16% | − 13% |
| Total | (+)side *3 | + 41% | − 13% | + 41% | − 13% |
| | (−)side *3 | − 26% | − 2% | − 26% | − 3% |

*1 : The variation of each product (standard value) shall be within ± 20% and variation of all (per project) products (total of standard values) shall be within ± 10%. However, if the total units of products is less than 8 units per project, the variation (total of standard values) shall be within ± 15%. (For $H_{eq}$, $\Sigma(H_{eq} \times K_{eq})/\Sigma K_{eq}$ shall be within 15%)
*2 : Predicted rate of change after 60 years at 20℃ 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.

# ● Compressive Properties

## ■ Compressive stiffness $K_V$

● Compressive stiffness $K_V$ shall be 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 $\sigma_{cr}$ at zero shear strain shall be determined by the following equation.

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

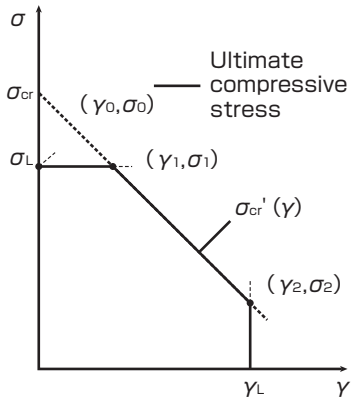
However, $E_b = E_{cr}(1 + 2/3 \cdot \kappa \cdot S_1^2) / \{1 + E_{cr}(1 + 2/3 \cdot \kappa \cdot S_1^2) / E_\infty\}$

$\alpha_c$ : Correction factor determined from our test data

Rubber Material X0.4R : $\alpha_c$=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 : $\alpha_c$=1.45 (if $S_2 \geqq 5$) $\alpha_c$=1.45 − 0.3 (5 − $S_2$) (if $5 > S_2$)

$E_{CR}$ : 3 × $G_{eq}$ $E_{CR}$ (=3 × 0.624) =1.872 (X0.6R) $E_{CR}$ (=3 × 0.392) =1.176 (X0.4R)




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

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

● The ultimate compressive stress shall not exceed the upper limit $\sigma_L$ determined as below and the strain region corresponding to the ultimate strain $\gamma_L$ at 0 compressive stress.

Rubber Material X0.4R : $\alpha_L$=40 (if $S_2 \geqq 5.0$) $\alpha_L$=40 + 10 ($S_2$ − 5) (if $5.0 > S_2 \geqq 3.0$)

$\gamma_L$ is defined as minimum value among 「400%」、「$S_2 \times 0.9 \times 100\%$」、「$(5.80 \times S_2 + 9.05)/(S_2 + 4.49) \times 100\%$」

Rubber Material X0.6R : $\alpha_L$=60 (if $S_2 \geqq 4.9$) $\alpha_L$=48 + 14 ($S_2$ − 4) (if $4.9 > S_2 \geqq 4.0$)

$\alpha_L$=24 + 24 ($S_2$ − 3) (if $4.0 > S_2 \geqq 3.5$) $\alpha_L$=22 + 28 ($S_2$ − 3) (if $3.5 > S_2 \geqq 3.0$)

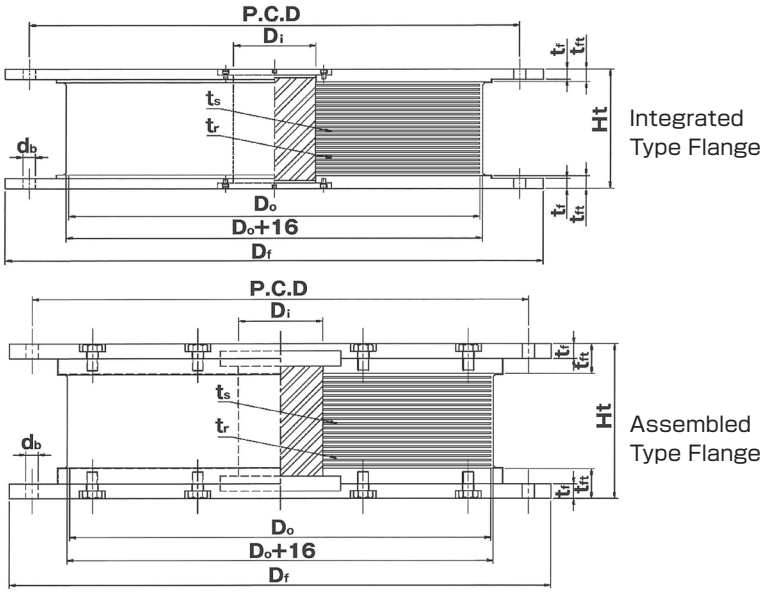
$\gamma_L$ is defined as minimum value among 「400%」、「$S_2 \times 0.9 \times 100\%$」、「$(5.00 \times S_2 + 9.05)/(S_2 + 4.49) \times 100\%$」

# Lead Rubber Bearing (LRB)

Seismic isolation material certification number by Ministry of Land, Infrastructure and Transport

MVBR-0447 Acquired in February 2012

## Product Dimension

| Item | | Description |
|---|---|---|
| Shape & dimensions of each part | Outer diameter : $D_0$ (mm) |  |
| | Lead plug diameter : $D_i$ (mm) | |
| | Effective plane area : $A_r$ ($\times 10^2 mm^2$) | |
| | Thickness of each rubber layer : $t_r$ (mm) | |
| | Number of rubber layers : n | |
| | Total rubber thickness : $H = n \times t_r$ (mm) | |
| | First shape factor $S_1 = D_0 / (4 \times t_r)$ | |
| | Second shape factor $S_2 = D_0 / (n \times t_r)$ | |
| | Diameter of flange : $D_f$ (mm) | |
| | Thickness of flange: edge/center : $t_f / t_{ft}$ (mm) | |
| | Connecting bolt PCD : PCD (mm) | |
| | Diameter of connecting bolt hole x qty : $d_b$ (mm) x qty | |
| | Bolt size (assumption) : M ($d_b$−3) | |
| | Thickness of each reinforced steel plate : $t_s$ (mm) | |
| | Total height : $H_t$ (mm) | |
| | Total weight 1 (kN) = 1/9.80665 (tonf) | |



## Rubber Material

Rubber code
(standard temperature 20℃ standard strain y = 100%)

| Rubber code | Shear modulus $G_{eq}$ ($N/mm^2$) |
|---|---|
| G4 | 0.385 |

Combination of rubber materials (weight ratio %)

| Rubber designation | Natural rubber Synthetic rubber | Reinforcement agent, Filler | Vulcanization agent and others |
|---|---|---|---|
| Rubber layers (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

| Item | Tensile strength ($N/mm^2$) | Elongation at Break (%) | Hardness (JIS A) | 100% modulus ($N/mm^2$) | Young's modulus E ($N/mm^2$) | Bulk modulus $E_\infty$ ($N/mm^2$) | Young's modulus correction factor according to hardness |
|---|---|---|---|---|---|---|---|
| Test Standard | JIS K6251 | JIS K6251 | JIS K6253 | JIS K6251 | | | |
| 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

Each steel part

| | Material |
|---|---|
| Reinforced steel plate | SS400 (JIS G 3101) |
| Flange plate *1 | SS400 (JIS G 3101) |
| Connecting plate *1 | SS400 (JIS G 3101) |
| Lead plug | Pb (JIS H 2105 special) |

*1 : Optionally SM490 (JIS G 3106).

Anti-rust treatment of flange plate

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

*1: Standard color is gray.
*2: Others anti-rust treatment of flange plate than painting are also available. Please contact us for more details.

## 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. Please contact us if you have any questions.

# ● Shear Properties

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

Shear properties of LRB is dependent on shear strain amplitude.
The shear strain dependency of each property is expressed by 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 $0.385 N/mm^2$
$\gamma$ : shear strain
$\alpha_p$ : apparent shear modulus of lead $0.583 N/mm^2$

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

Characteristics strength : $Q_d = C_{Qd} \cdot \sigma_{pb} \cdot A_p$
Where, $C_{Qd}$ : characteristic strength correction factor due to strain dependency
$\sigma_{pb}$ : Shear stress at yield of lead $7.967 N/mm^2$

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

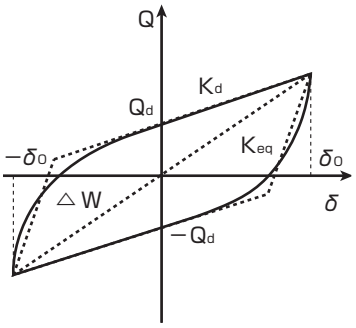
Initial stiffness : $K_1 = \beta \cdot K_d$
Where, $\beta$ : Ratio of initial stiffness to post-yield stiffness which is between 10 ~ 15. (recommended value: 13)

Equivalent shear stiffness $K_{eq}$

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

Equivalent damping ratio

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




## ■ Temperature dependency

Each shear property is corrected to the value at standard temperature of 20℃ by following equations.
(Applicable: − 20 ≦ T ≦ 40℃ ) (T: Temperature during inspection)

● Temperature correction equation : $K_d$ (corrected value at 20℃) = $K_d$ (T℃) / $(1.052 - 2.955 \times 10^{-3} \cdot T + 1.895 \times 10^{-5} \cdot T^2)$
: $Q_d$ (corrected value at 20℃) = $Q_d$ (T℃) / $(1.192 - 1.017 \times 10^{-2} \cdot T + 2.722 \times 10^{-5} \cdot T^2)$

● Standard value of temperature dependency Standard temperature (20℃ ) *1

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

*1 : 20% variation is considered in the rate of change

## ■ Performance variation

The rate of change of main causes (manufacturing variation, aging, temperature change) which affect shear properties shall be shown as below.

| Rubber materials | | 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 | Within +26% | Within +33% |
| | (-) side | Within -15% | Within -31% |

*2 : The variation of each product (standard value) shall be within ± 20% and variation of all (per project) products (total of standard values) shall be within ± 10%. However, if the total units of products is less than 8 units per project, the variation (total of standard values) shall be within ± 15%.
(Reference: For compressive stiffness Kv, variation of each product (standard value) shall be within ± 20%.)

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

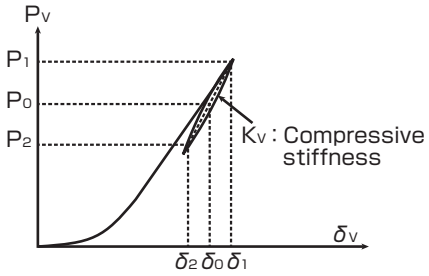
# ● Compressive Properties

## ■ Compressive stiffness $K_V$

● Compressive stiffness $K_V$ shall be 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 area
$A_r$ : Effective plane area
$A_p$ : Lead plug plane area
$A = A_r + A_p$
$\alpha_V$: Young's modulus correction factor $= 1.23$
*Compared to MVBR-0380, $\alpha_V$ has been revised from 1.30 to 1.23.




## ■ Ultimate compressive stress (refer figure on the right)

● Critical stress $\sigma_{cr}$ at zero shear strain shall be determined by the following equation.

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

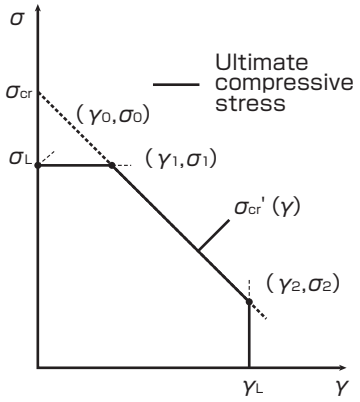
However, $E_b = E\,(1 + 2/3 \cdot \kappa \cdot S_1^2) \,/\, \{1 + E\,(1 + 2/3 \cdot \kappa \cdot S_1^2) \,/ E_\infty\}$
$\alpha_c$ : Correction factor determined from our test data based on $S_2$
If $S_2 \geqq 5 : \alpha_c = 1$, if $S_2 < 5 : \alpha_c = 0.25 \cdot (S_2 - 5) + 1$

● Ultimate compressive stress at any shear strain $\sigma_{cr}'(\gamma)$ shall be determined by $\sigma_{cr}$ in 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 $\sigma_L$ determined as below and the strain region corresponding to the ultimate strain $\gamma_L$ at 0 compressive stress.

$\sigma_L = 60 \quad (N/mm^2)$
$\gamma_L = \min(400\%, S_2 \times 100\%)$

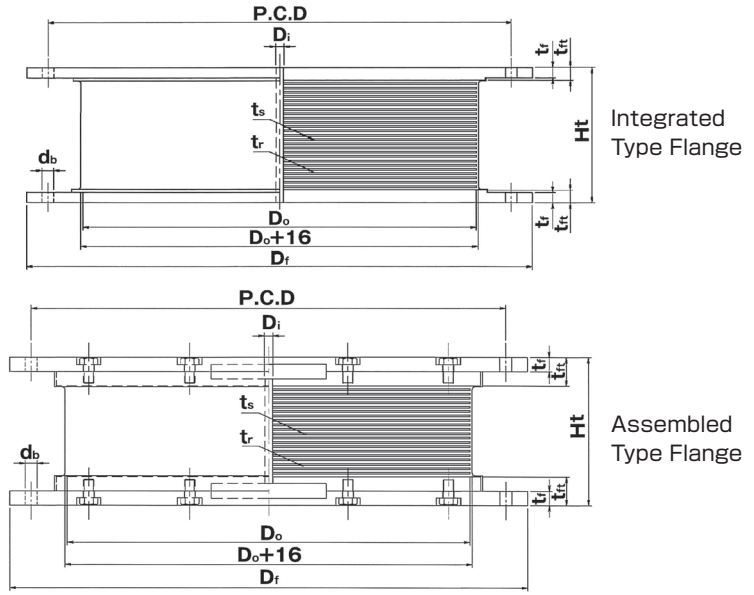


# Natural Rubber Bearing (NRB)

Seismic isolation material certification number by Ministry of Land, Infrastructure and Transport

MVBR-0295 (N3, G3, G5) Acquired in January 2006
MVBR-0446 (G4) Acquired in February 2012

## Product Dimension

| Item | | Description |
|---|---|---|
| Shape & dimensions of each part | Outer diameter : $D_o$ (mm) |  |
| | Inner diameter : $D_i$ (mm) | |
| | Effective plane area : A ($\times 10^2 mm^2$) | |
| | Thickness of each rubber layer : $t_r$ (mm) | |
| | Number of rubber layers : n | |
| | Total rubber thickness : $H = n \times t_r$ (mm) | |
| | First shape factor $S_1 = (D_o - D_i) / (4 \times t_r)$ | |
| | Second shape factor $S_2 = D_o / (n \times t_r)$ | |
| | Diameter of flange : $D_f$ (mm) | |
| | Thickness of flange: edge/center : $t_f/t_{ft}$ (mm) | |
| | Connecting bolt PCD : PCD (mm) | |
| | Diameter of connecting bolt hole x qty : $d_b$ (mm) x qty | |
| | Bolt size (assumption) : M ($d_b$−3) | |
| | Thickness of each reinforced steel plate : $t_s$ (mm) | |
| | Total height : $H_t$ (mm) | |
| | Total weight 1 (kN) = 1/9.80665 (tonf) | |



## Rubber Material

Rubber code
(standard temperature 20℃ standard strain y = 100%)

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

Combination of rubber materials (weight ratio %)

| Rubber designation | | Natural rubber Synthetic rubber | Reinforcement agent, Filler | Vulcanization agent and others |
|---|---|---|---|---|
| Rubber layers | 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 | 40 and below |

Properties of rubber materials

| Item | | Tensile strength ($N/mm^2$) | Elongation at Break (%) | Hardness (JIS A) | 100% modulus ($N/mm^2$) | Young's modulus E ($N/mm^2$) | Bulk modulus $E_\infty$ ($N/mm^2$) | Young's modulus correction factor according to hardness |
|---|---|---|---|---|---|---|---|---|
| Test Standard | | JIS K6251 | JIS K6251 | JIS K6253 | JIS K6251 | | | |
| 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

Each steel part

| | Material |
|---|---|
| Reinforced steel plate | SS400 (JIS G 3101) |
| Flange plate *1 | SS400 (JIS G 3101) |
| Connecting plate *1 | SS400 (JIS G 3101) |

*1: Optionally SM490 (JIS G 3106).

Anti-rust treatment of flange plate

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

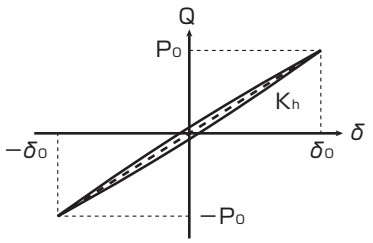
*1: Standard color is gray.
*2: Others anti-rust treatment of flange plate than painting are also available. Please contact us for more details.

# ● Shear Properties

## ■ Shear stiffness $K_h$

NRB shows linear restoring force characteristics in horizontal direction.
Shear stiffness $K_h$ shall be expressed in the following equations.

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




$\delta_0$ : Displacement equivalent to 100% strain
$P_0$ : Maximum load
$K_h$ : Shear stiffness (secant stiffness)
$G_{eq}$ : Shear modulus

## ■ Temperature dependency

Each shear property is corrected to the value at standard temperature of 20℃ by following equations.
(Applicable range: − 10 ≦ T ≦ 40℃ ) (T: Temperature during inspection)

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

● Standard value of temperature dependency Standard temperature (20℃ ) *1

| Properties values | -10℃ | 0℃ | 30℃ | 40℃ |
|---|---|---|---|---|
| Shear stiffness $K_h$ | 8% | 6% | − 3% | − 5% |

*1 : 20% variation is considered in the rate of change

## ■ Performance variation

The rate of change of main causes (manufacturing variation, aging, temperature change) which affect shear properties shall be shown as below.

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

*2 : The variation of each product (standard value) shall be within ± 20% and variation of all (per project) products (total of standard values) shall be within ± 10%.
However, if the total units of products is less than 8 units per project, the variation (total of standard values) shall be within ± 15%.
(Reference: For compressive stiffness Kv, variation of each product (standard value) shall be within ± 20%.)

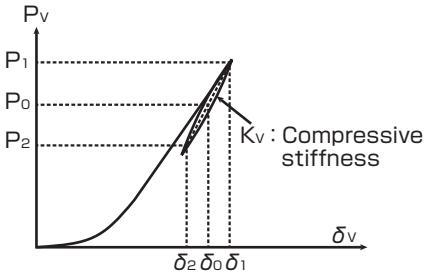
*3 : Predicted rate of change after 60 years at 20℃ standard temperature.
(20% variation is considered in the rate of change)

# ● Compressive Properties

## ■ Compressive stiffness $K_V$

● Compressive stiffness $K_V$ shall be determined by the following equation.

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



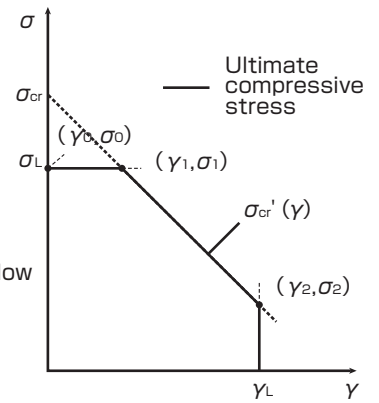

## ■ Ultimate compressive stress (refer figure on the right)

● Critical stress $\sigma_{cr}$ at zero shear strain shall be determined by the following equation.

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

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

$\sigma_{cr}'(\gamma) = \sigma_{cr} \cdot (1 - \beta_c \cdot \gamma / S_2)$
$\beta_c$: Correction factor determined from our test data based on $S_2$
$\alpha_c$ and $\beta_c$ are shown in the values below.
If $S_2 \geqq 5$ : $\alpha_c = 1$、 $\beta_c = 0.76$
If $S_2 < 5$ : $\alpha_c = 0.10 \cdot (S_2 - 5) + 1$、 $\beta_c = 0.76 / \{0.15 \cdot (S_2 - 5) + 1\}$




● The ultimate compressive stress shall not exceed the upper limit $\sigma_L$ determined as below and the strain region corresponding to the ultimate strain $\gamma_L$ at 0 compressive stress.

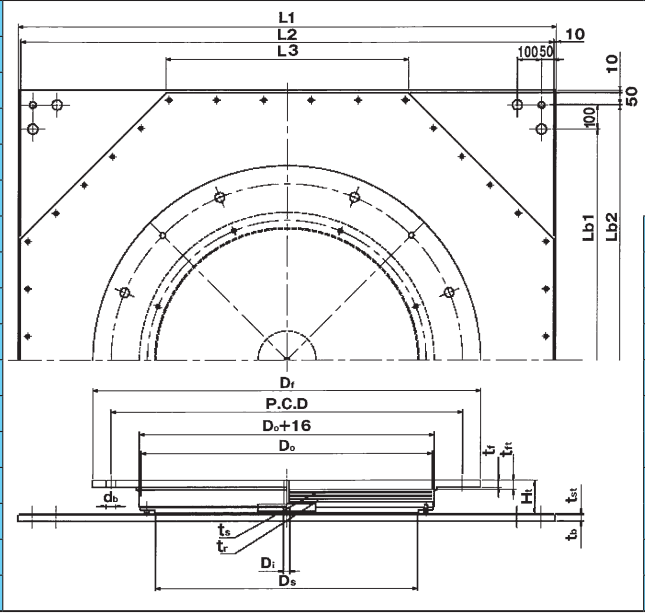
For rubber materials (designation) G0.30、G0.35 : $\sigma_L = 40$ $(N/mm^2)$
For rubber materials (designation) G0.40、G0.45 : $\sigma_L = 60$ $(N/mm^2)$
$\gamma_L$ = min (400%, $S_2 \times 100\%$)

# Elastic Sliding Bearing

Seismic isolation material certification number by Ministry of Land, Infrastructure and Transport

MVBR-0349 (SL Series) Acquired in June 2007
MVBR-0469 (SP Series, G0.4 Type) Acquired in December 2012
MVBR-0479 (SK Series, G0.4 Type) Acquired in May 2013

## Product Dimension

| Item | | Plan and Sectional View |
|---|---|---|
| Dimensions | Outer diameter : $D_0$ (mm) |  |
| | Inner diameter : $D_i$ (mm) | |
| | Effective diameter (outer diameter of sliding Plate) : $D_s$ (mm) | |
| | Effective plane area : A ($\times 10^2 mm^2$) | |
| | Thickness of each rubber layer : $t_r$ (mm) | |
| | Number of rubber layers : n | |
| | Total rubber thickness : $H = n \times t_r$ (mm) | |
| | First shape factor $S_1 = (D_0 - D_i) / (4 \times t_r)$ | |
| | Second shape factor $S_2 = D_0 / (n \times t_r)$ | |
| | Diameter of flange : $D_f$ (mm) | |
| | Thickness of flange: edge/center : $t_f/t_{ft}$ (mm) | |
| | Connecting bolt PCD : PCD (mm) | |
| | Diameter of connecting bolt hole x qty : $d_b$ (mm) x qty | |
| | Bolt size (assumption) : M ($d_b$–3) | |
| | Thickness of each reinforced steel plate : $t_s$ (mm) | |
| | Total height : $H_t$ (mm) | |
| | Total weight 1 (kN) = 1/9.80665 (tonf) | |



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

## Rubber Material

Notation of rubber kind
(standard temperature 20℃ standard strain y = 100%)

| Series | Rubber code | Rubber name | Shear modulus $G_{eq}(N/mm^2)$ |
|---|---|---|---|
| SK | G4 | G0.4 | 0.392 |
| SL | GC | G1.2 | 1.18 |

Composition of rubber materials (weight ratio %)

| Rubber name | | Natural rubber Synthetic rubber | Reinforcement agent, Filler | Vulcanization agent and others |
|---|---|---|---|---|
| Rubber layers | G0.4 | 60 or above | 10 or above | 25 or below |
| | G1.2 | 60 or above | 10 or above | 25 or below |
| Cover rubber | | 40 or above | 15 or above | 40 or below |

Properties of rubber materials

| Item | | Tensile strength ($N/mm^2$) | Elongation at Break (%) | Hardness (JIS A) | 100% modulus ($N/mm^2$) | Young's modulus E ($N/mm^2$) | Bulk modulus $E_\infty$ ($N/mm^2$) | Young's modulus correction factor according to hardness |
|---|---|---|---|---|---|---|---|---|
| Test Standard | | JIS K6251 (ISO 37) | JIS K6251 (ISO 37) | JIS K6253 (ISO 7619-1) | JIS K6251 (ISO 37) | | | |
| Inner rubber | G0.4 | 17 or above | 600 or above | 37 ± 5 | 0.8 ± 0.2 | 2.20 | 1200 | 0.85 |
| | G1.2 | 15 or above | 550 or above | 65 ± 5 | 2.45 ± 0.69 | 5.88 | 1569 | 0.53 |
| Cover rubber | | 12 or above | 600 or above | – | – | | | |

## Sliding Material and Sliding Plate Coating

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

| SK Series | Tetrafluoroethylene | Filler |
|---|---|---|
| Sliding material | 80 | 20 |
| Sliding plate coating | 55 | 45 |

| SL Series | Tetrafluoroethylene | Glass fiber | Molybdenum disulfide |
|---|---|---|---|
| Sliding material | 80 | 15 | 5 |
| Sliding plate | SUS (polished by #400 and above) | | |

# Steel Material

Steel material for each part

| | | Material |
|---|---|---|
| Reinforced steel plate | | SS400 (JIS G 3101) |
| Flange plate | | SS400 (JIS G 3101) |
| Sliding plate | Stainless plate | SUS304, SUS316 (JIS G 4304, G 4305) |
| | Base plate | SS400 (JIS G 3101) |

Anti-rust treatment of base plate

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

*1: Standard color is gray.
*2: Other kinds of anti-rust treatment are also available.
Please contact us for more details.

# Shear Properties

## Initial stiffness $K_1$

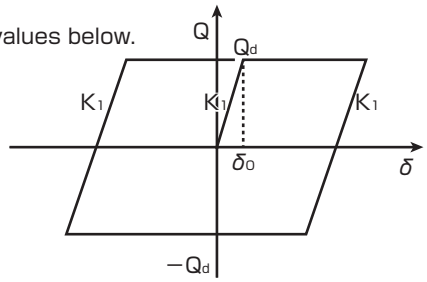
Initial stiffness $K_1$ of elastic sliding bearing is expressed in the following equations.

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

Shear modulus $G_{eq}$ for computation of the initial stiffness shall be adopted from the values below.

| | SK series | SL series |
|---|---|---|
| Shear modulus $G_{eq}$ (N/mm$^2$) | 0.49 | 1.18 |

※ Please note that starting from MVBR-0469, the shear modulus $G_{eq}$ for computation of the initial stiffness have been changed.




μ : Friction coefficient
Pv: Compressive load
$K_1$: Initial stiffness
δ : Horizontal deformation
$Q_d$: Yield load
(characteristic strength)

## Compressive stress dependency and velocity dependency of friction coefficient

Compressive stress dependency and velocity dependency of the friction coefficient μ are expressed in the following equations.

● For SK series ( μ 0.011, Type G0.4)

$$\mu = 0.0424 \cdot \sigma^{-0.510} \cdot V^{0.0894}$$

● For SL series ( μ 0.13, Type G1.2)

$$\mu = (0.112 - 0.00276 \cdot \sigma) \cdot V^{0.0863}$$

σ : compressve stress (N/mm$^2$)  V: velocity (mm/s)

## Temperature dependency of initial stiffness

● Standard values for temperature dependency  Standard temperature (20℃ ) *1

| Properties values | | -10℃ | 0℃ | 30℃ | 40℃ |
|---|---|---|---|---|---|
| Initial stiffness | SK series | Within +8% | Within +6% | Within -3% | Within -5% |
| | SL series | Within +14% | Within +9% | Within -4% | Within -8% |

*1 : Expected change ratio of initial stiffness at each temperature to the initial stifness at 20 deg. celcius. 20% variation is considered in the rate of change.

## Property variation

Property variation by each factors such as manufacturing tolerance, aging and temperature.

| Series | | SK series ( μ =0.011, type G0.4) | | SL series ( μ =0.13, type G1.2) | |
|---|---|---|---|---|---|
| Properties | | Fricition coefficient μ | Initial stiffness $K_1$ | Fricition coefficient μ | Initial stiffness $K_1$ |
| Manufacturing tolerance *2 | | Within ± 40% | Within ± 30% | Within ± 20% | Within ± 30% |
| Aging *3 | | – | Within +10% | – | Within +16% |
| Ambient temperature variation 20℃± 20℃ | (+) side | – | Within +6% | – | Within +9% |
| | (-) side | – | Within -5% | – | Within -8% |
| Total | (+) side | Within +40% | Within +46% | Within +20% | Within +55% |
| | (-) side | Within -40% | Within -35% | Within -20% | Within -38% |

*2 : The variation for both friction coefficient μ and initial stiffness K1 of each product shall be within the required variation range.
Reference: For compressive stiffness Kv, variation shall be within ± 20% for SL series and ± 30% for SK series.

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

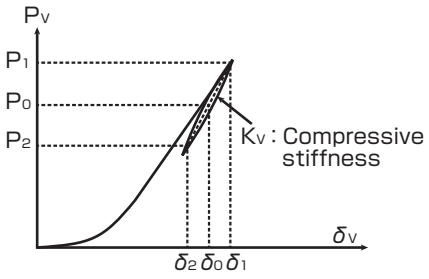
# ● Compressive Properties

## ■ Compressive stiffness $K_V$

● Design Compressive stiffness $K_V$ is calculated by the following equations.

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

$\alpha_V$ : 0.85 (newly introduced in MVBR-0469)

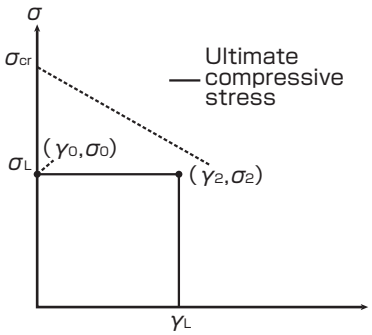



## ■ Ultimate compressive stress (refer to the figures on the right)

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

For SK series ( $\mu$ =0.011, type G0.4) : $\sigma_L = 80$ (N/mm$^2$)
For SL series ( $\mu$ =0.13, type G1.2) : $\sigma_L = 50$ (N/mm$^2$)

● The ultimate deformation shall be determined by the relationship between bearing diameter and sliding plate dimension.
For SK series : 1275mm , For SL series : 700mm.



# Design Characteristics of High Damping Rubber Bearing

## Dimension and Performance Properties of H-RB

### HH-Series (Total Rabber Thickness 200mm)

**Code**

| Designation | Compound | Shear Modulus ($N/mm^2$) | Equivalent Damping Ratio |
|---|---|---|---|
| X4R | X0.4R | 0.392 | 0.220 |

| Characteristics | | | HH060X4R | HH065X4R | HH070X4R | HH075X4R | HH080X4R | HH085X4R | HH090X4R | HH095X4R | HH100X4R | HH110X4R | HH120X4R | HH130X4R | HH140X4R | HH150X4R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Physical Dimensions | Outer Diameter (mm) | | 600 | 650 | 700 | 750 | 800 | 850 | 900 | 950 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 |
| | Inner Diameter (mm) | | 15 | 15 | 15 | 15 | 20 | 20 | 20 | 20 | 25 | 55 | 55 | 55 | 65 | 65 |
| | Effective Plane Area ($\times 10^2 mm^2$) | | 2826 | 3317 | 3847 | 4416 | 5023 | 5671 | 6359 | 7085 | 7849 | 9480 | 11286 | 13249 | 15361 | 17638 |
| | Thickness of One Rubber Layer (mm) | | 4.0 | 4.4 | 4.7 | 5.0 | 5.4 | 5.7 | 6.0 | 6.4 | 6.7 | 7.4 | 8.0 | 8.7 | 9.5 | 10 |
| | Number of Rubber Layers (–) | | 50 | 45 | 43 | 40 | 37 | 35 | 33 | 31 | 30 | 27 | 25 | 23 | 21 | 20 |
| | Total Rubber Thickness (mm) | | 200 | 198 | 202 | 200 | 200 | 200 | 198 | 198 | 201 | 200 | 200 | 200 | 200 | 200 |
| | First Shape Factor (–) | | 36.6 | 36.1 | 36.4 | 36.8 | 36.1 | 36.4 | 36.7 | 36.3 | 36.4 | 35.3 | 35.8 | 35.8 | 35.1 | 35.9 |
| | Second Shape Factor (–) | | 3.00 | 3.28 | 3.46 | 3.75 | 4.00 | 4.26 | 4.55 | 4.79 | 4.98 | 5.51 | 6.00 | 6.50 | 7.02 | 7.50 |
| | Diameter of Flange (mm) | | 900 | 950 | 1000 | 1100 | 1150 | 1200 | 1250 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 |
| | Thickness of Flange (mm) | | 22/28 | 22/28 | 22/28 | 22/28 | 24/32 | 24/32 | 28/36 | 28/36 | 28/36 | 30/38 | 32/40 | 32/40 | 50/100 | 50/100 |
| | Diameter of Bolt Center (mm) | | 775 | 825 | 875 | 950 | 1000 | 1050 | 1100 | 1150 | 1250 | 1350 | 1450 | 1550 | 1650 | 1700 |
| | Diameter (Number) of Fixing bolts (mm) | | φ33×12 | φ33×12 | φ33×12 | φ33×12 | φ33×12 | φ33×12 | φ33×12 | φ33×12 | φ39×12 | φ39×12 | φ39×12 | φ39×12 | φ42×12 | φ42×12 |
| | Supposed Bolt (–) | | M30 | M30 | M30 | M30 | M30 | M30 | M30 | M30 | M36 | M36 | M36 | M36 | M39 | M39 |
| | Thickness of One Reinforcing Steel Plate (mm) | | 3.1 | 3.1 | 3.1 | 3.1 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 5.8 | 5.8 |
| | Height (mm) | | 407.9 | 390.4 | 388.3 | 376.9 | 422.2 | 413.1 | 410.8 | 402.4 | 400.6 | 390.2 | 385.6 | 376.9 | 515.5 | 510.2 |
| | Total Weight (KN) | | 6.5 | 7.0 | 7.9 | 8.9 | 11.9 | 12.9 | 14.6 | 15.6 | 17.3 | 20.1 | 23.3 | 26.0 | 50.1 | 55.2 |
| Compression Properties | Critical Stress ($N/mm^2$) | $\gamma=0$ $\sigma_{cr}$ | 26 | 29 | 31 | 36 | 39 | 42 | 46 | 49 | 52 | 57 | 62 | 68 | 73 | 78 |
| | Ultimate Compressive Stress ($N/mm^2$) | ($\gamma_0, \sigma_0$) | (0,20) | (0,23) | (0,25) | (0,28) | (0,30) | (0,33) | (0,35) | (0,38) | (0,40) | (0,40) | (0,40) | (0,40) | (0,40) | (0,40) |
| | | ($\gamma_1, \sigma_1$) | (0.7,20) | (0.7,23) | (0.8,25) | (0.8,28) | (0.8,30) | (0.9,33) | (0.9,35) | (1.0,38) | (1.1,40) | (1.6,40) | (2.1,40) | (2.6,40) | (3.1,40) | (3.6,40) |
| | | ($\gamma_2, \sigma_2$) | (2.7,3) | (2.9,3) | (3.1,3) | (3.3,3) | (3.6,4) | (3.8,4) | (3.9,6) | (3.9,8) | (4.0,10) | (4.0,15) | (4.0,20) | (4.0,25) | (4.0,31) | (4.0,36) |
| | Compressive Stiffness ($\times 10^3 kN/m$) | | 1700 | 2020 | 2290 | 2660 | 3030 | 3420 | 3870 | 4300 | 4700 | 5690 | 6780 | 7960 | 9230 | 10600 |
| | Nominal Long Term Compressive Stress ($N/mm^2$) | | 4.6 $^{+0.0}_{-1.5}$ | 5.5 $^{+0.0}_{-1.8}$ | 6.1 $^{+0.0}_{-2.0}$ | 7.0 $^{+0.0}_{-2.3}$ | 7.8 $^{+0.0}_{-2.6}$ | 8.6 $^{+0.0}_{-2.9}$ | 9.5 $^{+0.0}_{-3.2}$ | 10.3 $^{+0.0}_{-3.4}$ | 10.9 $^{+0.0}_{-3.6}$ | 11.0 $^{+0.0}_{-3.7}$ | 11.0 $^{+0.0}_{-3.7}$ | 11.0 $^{+0.0}_{-3.7}$ | 11.0 $^{+0.0}_{-3.7}$ | 11.0 $^{+0.0}_{-3.7}$ |
| | Nominal Long Term Column Load (kN) | | 1300 | 1830 | 2340 | 3090 | 3920 | 4900 | 6070 | 7310 | 8570 | 10400 | 12400 | 14600 | 16900 | 19400 |
| | Allowable Tensile Stress ($\gamma$ =100%) ($N/mm^2$) | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Shear Properties ($\gamma$ =100%) | Initial Stiffness ($\times 10^3 kN/m$) | | 3.49 | 4.14 | 4.70 | 5.45 | 6.21 | 7.02 | 7.93 | 8.82 | 9.64 | 11.7 | 13.9 | 16.4 | 19.0 | 21.8 |
| | Post Yield Stiffness ($\gamma$ =100%) ($\times 10^3 kN/m$) | | 0.349 | 0.414 | 0.470 | 0.545 | 0.621 | 0.702 | 0.793 | 0.882 | 0.964 | 1.17 | 1.39 | 1.64 | 1.90 | 2.18 |
| | Characteristic Strength (kN) | | 41.0 | 48.1 | 55.8 | 64.1 | 72.9 | 82.3 | 92.2 | 103 | 114 | 137 | 164 | 192 | 223 | 256 |
| | Equivalent Shear Stiffness ($\times 10^3 kN/m$) | | 0.554 | 0.657 | 0.746 | 0.866 | 0.986 | 1.11 | 1.26 | 1.40 | 1.53 | 1.86 | 2.21 | 2.60 | 3.02 | 3.46 |
| | Equivalent Damping Ratio (–) | | 0.220 | 0.220 | 0.220 | 0.220 | 0.220 | 0.220 | 0.220 | 0.220 | 0.220 | 0.220 | 0.220 | 0.220 | 0.220 | 0.220 |

**Code**

| Designation | Compound | Shear Modulus ($N/mm^2$) | Equivalent Damping Ratio |
|---|---|---|---|
| X6R | X0.6R | 0.620 | 0.240 |

| Characteristics | | | HH060X6R | HH065X6R | HH070X6R | HH075X6R | HH080X6R | HH085X6R | HH090X6R | HH095X6R | HH100X6R | HH110X6R | HH120X6R | HH130X6R | HH140X6R | HH150X6R | HH160X6R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Physical Dimensions | Outer Diameter (mm) | | 600 | 650 | 700 | 750 | 800 | 850 | 900 | 950 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 |
| | Inner Diameter (mm) | | 15 | 15 | 15 | 15 | 20 | 20 | 20 | 20 | 25 | 55 | 55 | 55 | 65 | 65 | 80 |
| | Effective Plane Area ($\times 10^2 mm^2$) | | 2826 | 3317 | 3847 | 4416 | 5023 | 5671 | 6359 | 7085 | 7849 | 9480 | 11286 | 13249 | 15361 | 17638 | 20056 |
| | Thickness of One Rubber Layer (mm) | | 4.0 | 4.4 | 4.7 | 5.0 | 5.4 | 5.7 | 6.0 | 6.4 | 6.7 | 7.4 | 8.0 | 8.7 | 9.5 | 10.0 | 10.4 |
| | Number of Rubber Layers (–) | | 50 | 45 | 43 | 40 | 37 | 35 | 33 | 31 | 30 | 27 | 25 | 23 | 21 | 20 | 19 |
| | Total Rubber Thickness (mm) | | 200 | 198 | 202 | 200 | 200 | 200 | 198 | 198 | 201 | 200 | 200 | 200 | 200 | 200 | 198 |
| | First Shape Factor (–) | | 36.6 | 36.1 | 36.4 | 36.8 | 36.1 | 36.4 | 36.7 | 36.3 | 36.4 | 35.3 | 35.8 | 35.8 | 35.1 | 35.9 | 36.5 |
| | Second Shape Factor (–) | | 3.00 | 3.28 | 3.46 | 3.75 | 4.00 | 4.26 | 4.55 | 4.79 | 4.98 | 5.51 | 6.00 | 6.50 | 7.02 | 7.50 | 8.10 |
| | Diameter of Flange (mm) | | 900 | 950 | 1000 | 1100 | 1150 | 1200 | 1250 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 |
| | Thickness of Flange (mm) | | 22/28 | 22/28 | 22/28 | 22/28 | 24/32 | 24/32 | 28/36 | 28/36 | 28/36 | 30/38 | 32/40 | 32/40 | 37/45 | 42/50 | 50/110 |
| | Diameter of Bolt Center (mm) | | 775 | 825 | 875 | 950 | 1000 | 1050 | 1100 | 1150 | 1250 | 1350 | 1450 | 1550 | 1650 | 1750 | 1800 |
| | Diameter (Number) of Fixing bolts (mm) | | $\phi$33×12 | $\phi$33×12 | $\phi$33×12 | $\phi$33×12 | $\phi$33×12 | $\phi$33×12 | $\phi$33×12 | $\phi$33×12 | $\phi$39×12 | $\phi$39×12 | $\phi$39×12 | $\phi$39×12 | $\phi$42×12 | $\phi$42×16 | $\phi$45×12 |
| | Supposed Bolt (–) | | M30 | M30 | M30 | M30 | M30 | M30 | M30 | M30 | M36 | M36 | M36 | M36 | M39 | M39 | M42 |
| | Thickness of One Reinforcing Steel Plate (mm) | | 3.1 | 3.1 | 3.1 | 3.1 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 5.8 | 5.8 | 5.8 |
| | Height (mm) | | 407.9 | 390.4 | 388.3 | 376.9 | 422.2 | 413.1 | 410.8 | 402.4 | 400.6 | 390.2 | 385.6 | 376.9 | 405.5 | 410.2 | 522.0 |
| | Total Weight (KN) | | 6.5 | 7.0 | 7.9 | 8.9 | 11.9 | 12.9 | 14.6 | 15.6 | 17.3 | 20.1 | 23.3 | 26.0 | 33.9 | 39.9 | 65.1 |
| Compression Properties | Critical Stress ($N/mm^2$) | $\gamma$=0 $\sigma_{cr}$ | 43 | 52 | 58 | 69 | 78 | 89 | 101 | 113 | 122 | 136 | 148 | 160 | 173 | 185 | 200 |
| | Ultimate Compressive Stress ($N/mm^2$) | ($\gamma_0$, $\sigma_0$) | (0,22) | (0,30) | (0,35) | (0,42) | (0,48) | (0,52) | (0,56) | (0,59) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) |
| | | ($\gamma_1$, $\sigma_1$) | (1.5,22) | (1.4,30) | (1.4,35) | (1.5,42) | (1.6,48) | (1.8,52) | (2.1,56) | (2.3,59) | (2.5,60) | (3.1,60) | (3.6,60) | (3.8,60) | (3.8,60) | (3.9,60) | (3.9,60) |
| | | ($\gamma_2$, $\sigma_2$) | (2.7,4) | (3.0,5) | (3.1,6) | (3.4,7) | (3.4,11) | (3.5,17) | (3.5,23) | (3.6,29) | (3.6,34) | (3.7,46) | (3.7,56) | – | – | – | – |
| | Compressive Stiffness ($\times 10^3 kN/m$) | | 1970 | 2340 | 2660 | 3090 | 3510 | 3970 | 4490 | 4980 | 5450 | 6590 | 7860 | 9220 | 10700 | 12300 | 14200 |
| | Nominal Long Term Compressive Stress ($N/mm^2$) | | 6.6 $^{+0.0}_{-2.0}$ | 8.1 $^{+0.0}_{-2.7}$ | 9.1 $^{+0.0}_{-3.0}$ | 10.7 $^{+0.0}_{-3.5}$ | 12.0 $^{+0.0}_{-3.9}$ | 13.4 $^{+0.0}_{-4.4}$ | 15.0 $^{+0.0}_{-5.0}$ | 15.0 $^{+0.0}_{-5.0}$ | 15.0 $^{+0.0}_{-5.0}$ | 15.0 $^{+0.0}_{-5.0}$ | 15.0 $^{+0.0}_{-5.0}$ | 15.0 $^{+0.0}_{-5.0}$ | 15.0 $^{+0.0}_{-5.0}$ | 15.0 $^{+0.0}_{-5.0}$ | 15.0 $^{+0.0}_{-5.0}$ |
| | Nominal Long Term Column Load (kN) | | 1860 | 2690 | 3500 | 4710 | 6050 | 7620 | 9540 | 10600 | 11800 | 14200 | 16900 | 19900 | 23000 | 26500 | 30100 |
| | Allowable Tensile Stress ($\gamma$ =100%) ($N/mm^2$) | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Shear Properties ($\gamma$ =100%) | Initial Stiffness ($\times 10^3 kN/m$) | | 5.19 | 6.15 | 6.99 | 8.10 | 9.23 | 10.4 | 11.8 | 13.1 | 14.3 | 17.4 | 20.7 | 24.3 | 28.3 | 32.4 | 37.3 |
| | Post Yield Stiffness ($\gamma$ =100%) ($\times 10^3 kN/m$) | | 0.519 | 0.615 | 0.699 | 0.810 | 0.923 | 1.04 | 1.18 | 1.31 | 1.43 | 1.74 | 2.07 | 2.43 | 2.83 | 3.24 | 3.73 |
| | Characteristic Strength (kN) | | 71.5 | 83.9 | 97.3 | 112 | 127 | 143 | 161 | 179 | 199 | 240 | 285 | 335 | 389 | 446 | 507 |
| | Equivalent Shear Stiffness ($\times 10^3 kN/m$) | | 0.876 | 1.04 | 1.18 | 1.37 | 1.56 | 1.76 | 1.99 | 2.21 | 2.42 | 2.94 | 3.50 | 4.11 | 4.77 | 5.47 | 6.29 |
| | Equivalent Damping Ratio (–) | | 0.240 | 0.240 | 0.240 | 0.240 | 0.240 | 0.240 | 0.240 | 0.240 | 0.240 | 0.240 | 0.240 | 0.240 | 0.240 | 0.240 | 0.240 |

## HL-Series (Total Rabber Thickness 160mm)

**Code**

| Designation | Compound | Shear Modulus ($N/mm^2$) | Equivalent Damping Ratio |
|---|---|---|---|
| X4R | X0.4R | 0.392 | 0.220 |

| Characteristics | | | HL060X4R | HL065X4R | HL070X4R | HL075X4R | HL080X4R | HL085X4R | HL090X4R | HL100X4R | HL110X4R | HL120X4R | HL130X4R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Physical Dimensions | Outer Diameter (mm) | | 600 | 650 | 700 | 750 | 800 | 850 | 900 | 1000 | 1100 | 1200 | 1300 |
| | Inner Diameter (mm) | | 15 | 15 | 15 | 15 | 20 | 20 | 20 | 25 | 55 | 55 | 55 |
| | Effective Plane Area ($\times 10^2 mm^2$) | | 2826 | 3317 | 3847 | 4416 | 5023 | 5671 | 6359 | 7849 | 9480 | 11286 | 13249 |
| | Thickness of One Rubber Layer (mm) | | 3.95 | 4.4 | 4.9 | 4.85 | 5.1 | 5.25 | 5.65 | 6.35 | 7.2 | 7.7 | 8.0 |
| | Number of Rubber Layers (—) | | 41 | 37 | 34 | 34 | 33 | 32 | 30 | 26 | 23 | 22 | 21 |
| | Total Rubber Thickness (mm) | | 162 | 163 | 167 | 165 | 168 | 168 | 170 | 165 | 166 | 169 | 168 |
| | First Shape Factor (—) | | 37.0 | 36.1 | 34.9 | 37.9 | 38.2 | 39.5 | 38.9 | 38.4 | 36.3 | 37.2 | 38.9 |
| | Second Shape Factor (—) | | 3.70 | 3.99 | 4.20 | 4.55 | 4.75 | 5.06 | 5.31 | 6.06 | 6.64 | 7.08 | 7.74 |
| | Diameter of Flange (mm) | | 900 | 950 | 1000 | 1100 | 1150 | 1200 | 1250 | 1400 | 1500 | 1600 | 1700 |
| | Thickness of Flange (mm) | | 22/28 | 22/28 | 22/28 | 22/28 | 24/32 | 24/32 | 28/36 | 28/36 | 30/38 | 32/40 | 32/40 |
| | Diameter of Bolt Center (mm) | | 775 | 825 | 875 | 950 | 1000 | 1050 | 1100 | 1250 | 1350 | 1450 | 1550 |
| | Diameter (Number) of Fixing bolts (mm) | | $\phi$33×12 | $\phi$33×12 | $\phi$33×12 | $\phi$33×12 | $\phi$33×12 | $\phi$33×12 | $\phi$33×12 | $\phi$39×12 | $\phi$39×12 | $\phi$39×12 | $\phi$39×12 |
| | Supposed Bolt (—) | | M30 | M30 | M30 | M30 | M30 | M30 | M30 | M36 | M36 | M36 | M36 |
| | Thickness of One Reinforcing Steel Plate (mm) | | 3.1 | 3.1 | 3.1 | 3.1 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 5.8 |
| | Height (mm) | | 342.0 | 330.4 | 324.9 | 323.2 | 373.1 | 368.4 | 369.1 | 347.1 | 338.4 | 341.8 | 364.0 |
| | Total Weight (KN) | | 5.7 | 6.3 | 6.9 | 8.1 | 11.0 | 12.1 | 13.7 | 15.9 | 18.4 | 21.8 | 27.5 |
| Compression Properties | Critical Stress ($N/mm^2$) | $\gamma=0$ $\sigma_{cr}$ | 34 | 38 | 40 | 45 | 48 | 51 | 54 | 62 | 68 | 72 | 79 |
| | Ultimate Compressive Stress ($N/mm^2$) | ($\gamma_0, \sigma_0$) | (0,27) | (0,30) | (0,32) | (0,35) | (0,38) | (0,40) | (0,40) | (0,40) | (0,40) | (0,40) | (0,40) |
| | | ($\gamma_1, \sigma_1$) | (0.8,27) | (0.8,30) | (0.9,32) | (0.9,35) | (1.0,38) | (1.1,40) | (1.4,40) | (2.1,40) | (2.7,40) | (3.2,40) | (3.8,40) |
| | | ($\gamma_2, \sigma_2$) | (3.3,3) | (3.5,4) | (3.7,4) | (3.9,6) | (3.9,8) | (4.0,11) | (4.0,13) | (4.0,21) | (4.0,27) | (4.0,31) | (4.0,38) |
| | Compressive Stiffness ($\times 10^3 kN/m$) | | 2110 | 2450 | 2760 | 3240 | 3620 | 4110 | 4560 | 5770 | 6890 | 8050 | 9590 |
| | Nominal Long Term Compressive Stress ($N/mm^2$) | | 6.9 $^{+0.0}_{-2.3}$ | 7.8 $^{+0.0}_{-2.6}$ | 8.4 $^{+0.0}_{-2.8}$ | 9.6 $^{+0.0}_{-3.2}$ | 10.2 $^{+0.0}_{-3.4}$ | 11.0 $^{+0.0}_{-3.7}$ | 11.0 $^{+0.0}_{-3.7}$ | 11.0 $^{+0.0}_{-3.7}$ | 11.0 $^{+0.0}_{-3.7}$ | 11.0 $^{+0.0}_{-3.7}$ | 11.0 $^{+0.0}_{-3.7}$ |
| | Nominal Long Term Column Load (kN) | | 1940 | 2580 | 3250 | 4220 | 5130 | 6240 | 6990 | 8630 | 10400 | 12400 | 14600 |
| | Allowable Tensile Stress ($\gamma$ =100%) ($N/mm^2$) | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Shear Properties ($\gamma$ =100%) | Initial Stiffness ($\times 10^3 kN/m$) | | 4.31 | 5.03 | 5.70 | 6.61 | 7.37 | 8.34 | 9.26 | 11.7 | 14.1 | 16.5 | 19.5 |
| | Post Yield Stiffness ($\gamma$ =100%) ($\times 10^3 kN/m$) | | 0.431 | 0.503 | 0.570 | 0.661 | 0.737 | 0.834 | 0.926 | 1.17 | 1.41 | 1.65 | 1.95 |
| | Characteristic Strength (kN) | | 41.0 | 48.1 | 55.8 | 64.1 | 72.9 | 82.3 | 92.2 | 114 | 137 | 164 | 192 |
| | Equivalent Shear Stiffness ($\times 10^3 kN/m$) | | 0.684 | 0.799 | 0.905 | 1.05 | 1.17 | 1.32 | 1.47 | 1.86 | 2.24 | 2.61 | 3.09 |
| | Equivalent Damping Ratio (—) | | 0.220 | 0.220 | 0.220 | 0.220 | 0.220 | 0.220 | 0.220 | 0.220 | 0.220 | 0.220 | 0.220 |

**Code**

| Designation | Compound | Shear Modulus ($N/mm^2$) | Equivalent Damping Ratio |
|---|---|---|---|
| X6R | X0.6R | 0.620 | 0.240 |

| Characteristics | | | HL060X6R | HL065X6R | HL070X6R | HL075X6R | HL080X6R | HL085X6R | HL090X6R | HL100X6R | HL110X6R | HL120X6R | HL130X6R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Physical Dimensions | Outer Diameter (mm) | | 600 | 650 | 700 | 750 | 800 | 850 | 900 | 1000 | 1100 | 1200 | 1300 |
| | Inner Diameter (mm) | | 15 | 15 | 15 | 15 | 20 | 20 | 20 | 25 | 55 | 55 | 55 |
| | Effective Plane Area ($\times 10^2 mm^2$) | | 2826 | 3317 | 3847 | 4416 | 5023 | 5671 | 6359 | 7849 | 9480 | 11286 | 13249 |
| | Thickness of One Rubber Layer (mm) | | 3.95 | 4.4 | 4.9 | 4.85 | 5.1 | 5.25 | 5.65 | 6.35 | 7.2 | 7.7 | 8.0 |
| | Number of Rubber Layers (–) | | 41 | 37 | 34 | 34 | 33 | 32 | 30 | 26 | 23 | 22 | 21 |
| | Total Rubber Thickness (mm) | | 162 | 163 | 167 | 165 | 168 | 168 | 170 | 165 | 166 | 169 | 168 |
| | First Shape Factor (–) | | 37.0 | 36.1 | 34.9 | 37.9 | 38.2 | 39.5 | 38.9 | 38.4 | 36.3 | 37.2 | 38.9 |
| | Second Shape Factor (–) | | 3.70 | 3.99 | 4.20 | 4.55 | 4.75 | 5.06 | 5.31 | 6.06 | 6.64 | 7.08 | 7.74 |
| | Diameter of Flange (mm) | | 900 | 950 | 1000 | 1100 | 1150 | 1200 | 1250 | 1400 | 1500 | 1600 | 1700 |
| | Thickness of Flange (mm) | | 22/28 | 22/28 | 22/28 | 22/28 | 24/32 | 24/32 | 28/36 | 28/36 | 30/38 | 32/40 | 32/40 |
| | Diameter of Bolt Center (mm) | | 775 | 825 | 875 | 950 | 1000 | 1050 | 1100 | 1250 | 1350 | 1450 | 1550 |
| | Diameter (Number) of Fixing bolts (mm) | | $\phi$33×12 | $\phi$33×12 | $\phi$33×12 | $\phi$33×12 | $\phi$33×12 | $\phi$33×12 | $\phi$33×12 | $\phi$39×12 | $\phi$39×12 | $\phi$39×12 | $\phi$39×12 |
| | Supposed Bolt (–) | | M30 | M30 | M30 | M30 | M30 | M30 | M30 | M36 | M36 | M36 | M36 |
| | Thickness of One Reinforcing Steel Plate (mm) | | 3.1 | 3.1 | 3.1 | 3.1 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 5.8 |
| | Height (mm) | | 342.0 | 330.4 | 324.9 | 323.2 | 373.1 | 368.4 | 369.1 | 347.1 | 338.4 | 341.8 | 364.0 |
| | Total Weight (KN) | | 5.7 | 6.3 | 6.9 | 8.1 | 11.0 | 12.1 | 13.7 | 15.9 | 18.4 | 21.8 | 27.5 |
| Compression Properties | Critical Stress ($N/mm^2$) | $\gamma=0$ $\sigma_{cr}$ | 67 | 78 | 86 | 102 | 111 | 125 | 131 | 149 | 164 | 175 | 191 |
| | Ultimate Compressive Stress ($N/mm^2$) | ($\gamma_0, \sigma_0$) | (0,41) | (0,48) | (0,51) | (0,56) | (0,59) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) |
| | | ($\gamma_1, \sigma_1$) | (1.4,41) | (1.5,48) | (1.7,51) | (2.1,56) | (2.2,59) | (2.6,60) | (2.9,60) | (3.6,60) | (3.8,60) | (3.8,60) | (3.9,60) |
| | | ($\gamma_2, \sigma_2$) | (3.3,7) | (3.4,11) | (3.5,15) | (3.5,23) | (3.6,28) | (3.6,36) | (3.6,41) | (3.7,57) | – | – | – |
| | Compressive Stiffness ($\times 10^3 kN/m$) | | 2440 | 2840 | 3200 | 3760 | 4190 | 4760 | 5280 | 6680 | 7990 | 9330 | 11100 |
| | Nominal Long Term Compressive Stress ($N/mm^2$) | | $10.4^{+0.0}_{-3.4}$ | $12.0^{+0.0}_{-3.9}$ | $13.1^{+0.0}_{-4.3}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ |
| | Nominal Long Term Column Load (kN) | | 2940 | 3970 | 5040 | 6620 | 7540 | 8510 | 9540 | 11800 | 14200 | 16900 | 19900 |
| | Allowable Tensile Stress ($\gamma$ =100%) ($N/mm^2$) | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Shear Properties ($\gamma$ =100%) | Initial Stiffness ($\times 10^3 kN/m$) | | 6.40 | 7.48 | 8.47 | 9.83 | 11.0 | 12.4 | 13.8 | 17.4 | 21.0 | 24.5 | 28.9 |
| | Post Yield Stiffness ($\gamma$ =100%) ($\times 10^3 kN/m$) | | 0.640 | 0.748 | 0.847 | 0.983 | 1.10 | 1.24 | 1.38 | 1.74 | 2.10 | 2.45 | 2.89 |
| | Characteristic Strength (kN) | | 71.5 | 83.9 | 97.3 | 112 | 127 | 143 | 161 | 199 | 240 | 285 | 335 |
| | Equivalent Shear Stiffness ($\times 10^3 kN/m$) | | 1.08 | 1.26 | 1.43 | 1.66 | 1.85 | 2.09 | 2.33 | 2.95 | 3.55 | 4.13 | 4.89 |
| | Equivalent Damping Ratio (–) | | 0.240 | 0.240 | 0.240 | 0.240 | 0.240 | 0.240 | 0.240 | 0.240 | 0.240 | 0.240 | 0.240 |

## ●H T-Series (Total Rabber Thickness 250mm)

**Code**

| Designation | Compound | Shear Modulus ($N/mm^2$) | Equivalent Damping Ratio |
|---|---|---|---|
| X4R | X0.4R | 0.392 | 0.220 |

| Characteristics | | | HT090X4R | HT095X4R | HT100X4R | HT110X4R | HT120X4R | HT130X4R | HT140X4R | HT150X4R |
|---|---|---|---|---|---|---|---|---|---|---|
| Physical Dimensions | Outer Diameter (mm) | | 900 | 950 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 |
| | Inner Diameter (mm) | | 20 | 20 | 25 | 55 | 55 | 55 | 65 | 65 |
| | Effective Plane Area ($\times 10^2 mm^2$) | | 6359 | 7085 | 7849 | 9480 | 11286 | 13249 | 15361 | 17638 |
| | Thickness of One Rubber Layer (mm) | | 6.0 | 6.4 | 6.7 | 7.4 | 8.0 | 8.7 | 9.5 | 10.0 |
| | Number of Rubber Layers (—) | | 42 | 39 | 37 | 34 | 31 | 29 | 26 | 25 |
| | Total Rubber Thickness (mm) | | 252 | 250 | 248 | 252 | 248 | 252 | 247 | 250 |
| | First Shape Factor (—) | | 36.7 | 36.3 | 36.4 | 35.3 | 35.8 | 35.8 | 35.1 | 35.9 |
| | Second Shape Factor (—) | | 3.57 | 3.81 | 4.03 | 4.37 | 4.84 | 5.15 | 5.67 | 6.00 |
| | Diameter of Flange (mm) | | 1250 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 |
| | Thickness of Flange (mm) | | 28/36 | 28/36 | 28/36 | 30/38 | 32/40 | 32/40 | 50/100 | 50/100 |
| | Diameter of Bolt Center※ (mm) | | 1100 | 1150 | 1250 | 1350 | 1450 | 1550 | 1650 | 1700 |
| | Diameter (Number) of Fixing bolts (mm) | | $\phi$33×12 | $\phi$33×12 | $\phi$39×12 | $\phi$39×12 | $\phi$39×12 | $\phi$39×12 | $\phi$42×12 | $\phi$42×12 |
| | Supposed Bolt (—) | | M30 | M30 | M36 | M36 | M36 | M36 | M39 | M39 |
| | Thickness of One Reinforcing Steel Plate (mm) | | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 5.8 | 5.8 |
| | Height (mm) | | 504.4 | 488.8 | 478.3 | 472.8 | 460.0 | 455.5 | 592.0 | 589.2 |
| | Total Weight (KN) | | 16.9 | 18.0 | 19.6 | 22.9 | 26.2 | 29.5 | 54.4 | 60.2 |
| Compression Properties | Critical Stress ($N/mm^2$) | $\gamma=0$ $\sigma_{cr}$ | 33 | 35 | 38 | 43 | 49 | 52 | 58 | 61 |
| | Ultimate Compressive Stress ($N/mm^2$) | ($\gamma_0, \sigma_0$) | (0,26) | (0,28) | (0,30) | (0,34) | (0,38) | (0,40) | (0,40) | (0,40) |
| | | ($\gamma_1, \sigma_1$) | (0.8,26) | (0.8,28) | (0.8,30) | (0.9,34) | (1.0,38) | (1.2,40) | (1.7,40) | (2.1,40) |
| | | ($\gamma_2, \sigma_2$) | (3.2,3.0) | (3.4,4.0) | (3.6,4.0) | (3.9,4.0) | (4.0,5.0) | (4.0,12) | (4.0,17) | (4.0,20) |
| | Compressive Stiffness ($\times 10^3 kN/m$) | | 3040 | 3420 | 3810 | 4520 | 5470 | 6310 | 7450 | 8480 |
| | Nominal Long Term Compressive Stress ($N/mm^2$) | | $6.4^{+0.0}_{-2.1}$ | $7.2^{+0.0}_{-2.4}$ | $7.9^{+0.0}_{-2.6}$ | $9.0^{+0.0}_{-3.0}$ | $10.5^{+0.0}_{-3.5}$ | $11.0^{+0.0}_{-3.7}$ | $11.0^{+0.0}_{-3.7}$ | $11.0^{+0.0}_{-3.7}$ |
| | Nominal Long Term Column Load (kN) | | 4090 | 5090 | 6210 | 8520 | 11800 | 14600 | 16900 | 19400 |
| | Allowable Tensile Stress ($\gamma$ =100%) ($N/mm^2$) | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Shear Properties ($\gamma$ =100%) | Initial Stiffness ($\times 10^3 kN/m$) | | 6.23 | 7.01 | 7.82 | 9.30 | 11.2 | 13.0 | 15.4 | 17.4 |
| | Post Yield Stiffness ($\gamma$ =100%) ($\times 10^3 kN/m$) | | 0.623 | 0.701 | 0.782 | 0.930 | 1.12 | 1.30 | 1.54 | 1.74 |
| | Characteristic Strength (kN) | | 92.2 | 103 | 114 | 137 | 164 | 192 | 223 | 256 |
| | Equivalent Shear Stiffness ($\times 10^3 kN/m$) | | 0.989 | 1.11 | 1.24 | 1.48 | 1.78 | 2.06 | 2.44 | 2.77 |
| | Equivalent Damping Ratio (—) | | 0.220 | 0.220 | 0.220 | 0.220 | 0.220 | 0.220 | 0.220 | 0.220 |

**Code**

| Designation | Compound | Shear Modulus ($N/mm^2$) | Equivalent Damping Ratio |
|---|---|---|---|
| X6R | X0.6R | 0.620 | 0.240 |

| Characteristics | | | HT090X6R | HT100X6R | HT110X6R | HT120X6R | HT130X6R | HT140X6R | HT150X6R | HT160X6R |
|---|---|---|---|---|---|---|---|---|---|---|
| Physical Dimensions | Outer Diameter (mm) | | 900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 |
| | Inner Diameter (mm) | | 20 | 25 | 55 | 55 | 55 | 65 | 65 | 80 |
| | Effective Plane Area ($\times 10^2 mm^2$) | | 6359 | 7849 | 9480 | 11286 | 13249 | 15361 | 17638 | 20056 |
| | Thickness of One Rubber Layer (mm) | | 6.0 | 6.7 | 7.4 | 8.0 | 8.7 | 9.5 | 10.0 | 10.4 |
| | Number of Rubber Layers (–) | | 42 | 37 | 34 | 31 | 29 | 26 | 25 | 24 |
| | Total Rubber Thickness (mm) | | 252 | 248 | 252 | 248 | 252 | 247 | 250 | 250 |
| | First Shape Factor (–) | | 36.7 | 36.4 | 35.3 | 35.8 | 35.8 | 35.1 | 35.9 | 36.5 |
| | Second Shape Factor (–) | | 3.57 | 4.03 | 4.37 | 4.84 | 5.15 | 5.67 | 6.00 | 6.41 |
| | Diameter of Flange (mm) | | 1250 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 |
| | Thickness of Flange (mm) | | 28/36 | 28/36 | 30/38 | 32/40 | 32/40 | 37/45 | 42/50 | 50/110 |
| | Diameter of Bolt Center※ (mm) | | 1100 | 1250 | 1350 | 1450 | 1550 | 1650 | 1750 | 1800 |
| | Diameter (Number) of Fixing bolts (mm) | | $\phi$33×12 | $\phi$39×12 | $\phi$39×12 | $\phi$39×12 | $\phi$39×12 | $\phi$42×12 | $\phi$42×16 | $\phi$45×12 |
| | Supposed Bolt (–) | | M30 | M36 | M36 | M36 | M36 | M39 | M39 | M42 |
| | Thickness of One Reinforcing Steel Plate (mm) | | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 5.8 | 5.8 | 5.8 |
| | Height (mm) | | 504.4 | 478.3 | 472.8 | 460 | 455.5 | 482 | 489.2 | 603.0 |
| | Total Weight (KN) | | 16.9 | 19.6 | 22.9 | 26.2 | 29.5 | 38.2 | 44.8 | 70.8 |
| Compression Properties | Critical Stress ($N/mm^2$) | $\gamma$=0 $\sigma_{cr}$ | 62 | 80 | 94 | 115 | 127 | 140 | 148 | 158 |
| | Ultimate Compressive Stress ($N/mm^2$) | ($\gamma_0, \sigma_0$) | (0,38) | (0,48) | (0,53) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) |
| | | ($\gamma_1, \sigma_1$) | (1.4,38) | (1.6,48) | (1.9,53) | (2.3,60) | (2.7,60) | (3.2,60) | (3.6,60) | (3.8,60) |
| | | ($\gamma_2, \sigma_2$) | (3.2,6) | (3.4,12) | (3.5,19) | (3.6,30) | (3.6,38) | (3.7,49) | (3.7,56) | – |
| | Compressive Stiffness ($\times 10^3 kN/m$) | | 3530 | 4420 | 5240 | 6340 | 7310 | 8640 | 9830 | 11200 |
| | Nominal Long Term Compressive Stress ($N/mm^2$) | | 9.7 $^{+0.0}_{-3.2}$ | 12.2 $^{+0.0}_{-4.0}$ | 14.0 $^{+0.0}_{-4.6}$ | 15.0 $^{+0.0}_{-5.0}$ | 15.0 $^{+0.0}_{-5.0}$ | 15.0 $^{+0.0}_{-5.0}$ | 15.0 $^{+0.0}_{-5.0}$ | 15.0 $^{+0.0}_{-5.0}$ |
| | Nominal Long Term Column Load (kN) | | 6170 | 9580 | 13300 | 16900 | 19900 | 23000 | 26500 | 30100 |
| | Allowable Tensile Stress ($\gamma$ =100%) ($N/mm^2$) | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Shear Properties ($\gamma$ =100%) | Initial Stiffness ($\times 10^3 kN/m$) | | 9.26 | 11.6 | 13.8 | 16.7 | 19.3 | 22.8 | 25.9 | 29.5 |
| | Post Yield Stiffness ($\gamma$ =100%) ($\times 10^3 kN/m$) | | 0.926 | 1.16 | 1.38 | 1.67 | 1.93 | 2.28 | 2.59 | 2.95 |
| | Characteristic Strength (kN) | | 161 | 199 | 240 | 285 | 335 | 389 | 446 | 507 |
| | Equivalent Shear Stiffness ($\times 10^3 kN/m$) | | 1.56 | 1.96 | 2.34 | 2.82 | 3.26 | 3.86 | 4.37 | 4.98 |
| | Equivalent Damping Ratio (–) | | 0.240 | 0.240 | 0.240 | 0.240 | 0.240 | 0.240 | 0.240 | 0.240 |

# Dimension and Performance Properties of L-RB

## LH-Series (Total Rabber Thickness 200mm)

**Code**

| Designation | Compound | Shear Modulus (N/mm$^2$) |
|---|---|---|
| G4 | G0.40 | 0.385 |

| Characteristics | | | LH060G4 | | | | | LH065G4 | | | | | LH070G4 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | C | B | A | G | H | C | B | A | G | H | C | B | A | G | H |
| Physical Dimensions | Outer Diameter (mm) | | 600 | | | | | 650 | | | | | 700 | | | | |
| | Inner Diameter (mm) | | 100 | 110 | 120 | 130 | 140 | 110 | 120 | 130 | 140 | 150 | 120 | 130 | 140 | 150 | 160 |
| | Effective Plane Area ($\times 10^2$mm$^2$) | | 2749 | 2732 | 2714 | 2695 | 2673 | 3223 | 3205 | 3186 | 3164 | 3142 | 3735 | 3716 | 3695 | 3672 | 3647 |
| | Thickness of One Rubber Layer (mm) | | 4.0 | | | | | 4.4 | | | | | 4.7 | | | | |
| | Number of Rubber Layers (–) | | 50 | | | | | 45 | | | | | 43 | | | | |
| | Total Rubber Thickness (mm) | | 200 | | | | | 198 | | | | | 202 | | | | |
| | First Shape Factor (–) | | 37.5 | | | | | 36.9 | | | | | 37.2 | | | | |
| | Second Shape Factor (–) | | 3.00 | | | | | 3.28 | | | | | 3.46 | | | | |
| | Diameter of Flange (mm) | | 900 | | | | | 950 | | | | | 1000 | | | | |
| | Thickness of Flange (mm) | | 22/28 | | | | | 22/28 | | | | | 22/28 | | | | |
| | Diameter of Bolt Center (mm) | | 775 | | | | | 825 | | | | | 875 | | | | |
| | Diameter (Number) of Fixing bolts (mm) | | $\phi$33×12 | | | | | $\phi$33×12 | | | | | $\phi$33×12 | | | | |
| | Supposed Bolt (–) | | M30 | | | | | M30 | | | | | M30 | | | | |
| | Thickness of One Reinforcing Steel Plate (mm) | | 3.1 | | | | | 3.1 | | | | | 3.1 | | | | |
| | Height (mm) | | 407.9 | | | | | 390.4 | | | | | 388.3 | | | | |
| | Total Weight (KN) | | 6.7 | 6.7 | 6.8 | 6.8 | 6.9 | 7.3 | 7.3 | 7.4 | 7.4 | 7.5 | 8.2 | 8.2 | 8.3 | 8.4 | 8.4 |
| Compression Properties | Critical Stress (N/mm$^2$) | $\gamma$=0 $\sigma_{cr}$ | (24.4) | | | | | (30.3) | | | | | (34.7) | | | | |
| | Ultimate Compressive Stress (N/mm$^2$) | ($\gamma_0$, $\sigma_0$) | (0.00,24.4) | | | | | (0.00,30.3) | | | | | (0.00,34.7) | | | | |
| | | ($\gamma_1$, $\sigma_1$) | – | | | | | – | | | | | – | | | | |
| | | ($\gamma_2$, $\sigma_2$) | (3.00,2.44) | | | | | (3.28,3.03) | | | | | (3.46,3.47) | | | | |
| | Compressive Stiffness ($\times 10^3$kN/m) | | 1670 | | | | | 1970 | | | | | 2250 | | | | |
| | Nominal Long Term Compressive Stress (N/mm$^2$) | | 6.0 $^{+0.9}_{-1.4}$ | | | | | 7.3 $^{+1.1}_{-1.7}$ | | | | | 8.1 $^{+1.2}_{-1.9}$ | | | | |
| | Nominal Long Term Column Load (kN) | | 1650 | 1640 | 1630 | 1620 | 1600 | 2350 | 2330 | 2320 | 2300 | 2290 | 3020 | 3010 | 2990 | 2970 | 2950 |
| | Allowable Tensile Stress ($\gamma$ =100%) (N/mm$^2$) | | 1.0 | | | | | 1.0 | | | | | 1.0 | | | | |
| Shear Properties ($\gamma$ =100%) | Initial Stiffness ($\times 10^3$kN/m) | | 7.18 | 7.20 | 7.22 | 7.25 | 7.27 | 8.51 | 8.53 | 8.56 | 8.59 | 8.62 | 9.67 | 9.70 | 9.73 | 9.76 | 9.79 |
| | Post Yield Stiffness ($\gamma$ =100%) ($\times 10^3$kN/m) | | 0.552 | 0.554 | 0.555 | 0.557 | 0.560 | 0.655 | 0.657 | 0.658 | 0.661 | 0.663 | 0.744 | 0.746 | 0.748 | 0.750 | 0.753 |
| | Characteristic Strength (kN) | | 63 | 76 | 90 | 106 | 123 | 76 | 90 | 106 | 123 | 141 | 90 | 106 | 123 | 141 | 160 |
| | Equivalent shear stiffness ($\times 10^3$kN/m) | | 0.87 | 0.93 | 1.01 | 1.09 | 1.17 | 1.04 | 1.11 | 1.19 | 1.28 | 1.37 | 1.19 | 1.27 | 1.35 | 1.45 | 1.55 |
| | Equivalent Damping Ratio (–) | | 0.219 | 0.244 | 0.266 | 0.285 | 0.302 | 0.223 | 0.246 | 0.266 | 0.284 | 0.300 | 0.227 | 0.247 | 0.266 | 0.283 | 0.298 |

It will NOT be able to supply our LRB(Lead Rubber Bearing) to 8 countries as China, Taiwan, Korea, Philippines, Malaysia, New Zealand, USA and Italy.

## LH-Series (Total Rabber Thickness 200mm)

| Characteristics | | | LH075G4 | | | | | LH080G4 | | | | | LH085G4 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | C | B | A | G | H | C | B | A | G | H | C | B | A | G | H |
| Physical Dimensions | Outer Diameter (mm) | | 750 | | | | | 800 | | | | | 850 | | | | |
| | Inner diameter (mm) | | 130 | 140 | 150 | 160 | 170 | 140 | 150 | 160 | 170 | 180 | 150 | 160 | 170 | 180 | 190 |
| | Effective Plane Area ($\times 10^2$mm$^2$) | | 4285 | 4264 | 4241 | 4217 | 4191 | 4873 | 4850 | 4825 | 4800 | 4772 | 5498 | 5473 | 5448 | 5420 | 5391 |
| | Thickness of One Rubber Layer (mm) | | 5.0 | | | | | 5.4 | | | | | 5.7 | | | | |
| | Number of Rubber Layers (–) | | 40 | | | | | 37 | | | | | 35 | | | | |
| | Total Rubber Thickness (mm) | | 200 | | | | | 200 | | | | | 200 | | | | |
| | First Shape Factor (–) | | 37.5 | | | | | 37.0 | | | | | 37.3 | | | | |
| | Second Shape Factor (–) | | 3.75 | | | | | 4.00 | | | | | 4.26 | | | | |
| | Diameter of Flange (mm) | | 1100 | | | | | 1150 | | | | | 1200 | | | | |
| | Thickness of Flange (mm) | | 22/28 | | | | | 24/32 | | | | | 24/32 | | | | |
| | Diameter of Bolt Center (mm) | | 950 | | | | | 1000 | | | | | 1050 | | | | |
| | Diameter (Number) of Fixing bolts (mm) | | $\phi$33×12 | | | | | $\phi$33×12 | | | | | $\phi$33×12 | | | | |
| | Supposed Bolt (–) | | M30 | | | | | M30 | | | | | M30 | | | | |
| | Thickness of One Reinforcing Steel Plate (mm) | | 3.1 | | | | | 4.4 | | | | | 4.4 | | | | |
| | Height (mm) | | 376.9 | | | | | 422.2 | | | | | 413.1 | | | | |
| | Total Weight (KN) | | 9.2 | 9.2 | 9.3 | 9.3 | 9.4 | 12.3 | 12.4 | 12.5 | 12.5 | 12.6 | 13.4 | 13.4 | 13.5 | 13.6 | 13.7 |
| Compression Properties | Critical Stress (N/mm$^2$) | $\gamma$=0 $\sigma_{cr}$ | (42.0) | | | | | (48.8) | | | | | (56.5) | | | | |
| | Ultimate Compressive Stress (N/mm$^2$) | ($\gamma_0$,$\sigma_0$) | (0.00,42.0) | | | | | (0.00,48.8) | | | | | (0.00,56.5) | | | | |
| | | ($\gamma_1$,$\sigma_1$) | – | | | | | – | | | | | – | | | | |
| | | ($\gamma_2$,$\sigma_2$) | (3.75,4.20) | | | | | (4.00,4.92) | | | | | (4.00,8.75) | | | | |
| | Compressive Stiffness ($\times 10^3$kN/m) | | 2610 | | | | | 2960 | | | | | 3360 | | | | |
| | Nominal Long Term Compressive Stress (N/mm$^2$) | | 9.4 $^{+1.4}_{-2.2}$ | | | | | 10.5 $^{+1.6}_{-2.4}$ | | | | | 11.7 $^{+1.8}_{-2.7}$ | | | | |
| | Nominal Long Term Column Load (kN) | | 4020 | 4000 | 3980 | 3960 | 3940 | 5130 | 5110 | 5080 | 5050 | 5020 | 6430 | 6400 | 6370 | 6340 | 6300 |
| | Allowable Tensile Stress ($\gamma$ =100%) (N/mm$^2$) | | 1.0 | | | | | 1.0 | | | | | 1.0 | | | | |
| Shear Properties ($\gamma$ =100%) | Initial Stiffness ($\times 10^3$kN/m) | | 11.2 | 11.3 | 11.3 | 11.3 | 11.3 | 12.8 | 12.8 | 12.9 | 12.9 | 12.9 | 14.5 | 14.5 | 14.5 | 14.6 | 14.6 |
| | Post Yield Stiffness ($\gamma$ =100%) ($\times 10^3$kN/m) | | 0.864 | 0.866 | 0.868 | 0.870 | 0.873 | 0.984 | 0.986 | 0.989 | 0.991 | 0.994 | 1.11 | 1.12 | 1.12 | 1.12 | 1.12 |
| | Characteristic Strength (kN) | | 106 | 123 | 141 | 160 | 181 | 123 | 141 | 160 | 181 | 203 | 141 | 160 | 181 | 203 | 226 |
| | Equivalent shear stiffness ($\times 10^3$kN/m) | | 1.39 | 1.48 | 1.57 | 1.67 | 1.78 | 1.60 | 1.69 | 1.79 | 1.90 | 2.01 | 1.82 | 1.92 | 2.02 | 2.14 | 2.26 |
| | Equivalent Damping Ratio (–) | | 0.229 | 0.248 | 0.266 | 0.282 | 0.296 | 0.232 | 0.250 | 0.266 | 0.281 | 0.294 | 0.234 | 0.251 | 0.266 | 0.280 | 0.293 |

It will NOT be able to supply our LRB(Lead Rubber Bearing) to 8 countries as China, Taiwan, Korea, Philippines, Malaysia, New Zealand, USA and Italy.

## LH-Series (Total Rabber Thickness 200mm)

| LH090G4 | | | | | LH095G4 | | | | | LH100G4 | | | | | LH110G4 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | B | A | G | H | C | B | A | G | H | C | B | A | G | H | C | B | A | G | H |
| 900 | | | | | 950 | | | | | 1000 | | | | | 1100 | | | | |
| 160 | 170 | 180 | 190 | 200 | 170 | 180 | 190 | 200 | 210 | 180 | 190 | 200 | 210 | 220 | 200 | 210 | 220 | 230 | 240 |
| 6161 | 6135 | 6107 | 6078 | 6048 | 6861 | 6834 | 6805 | 6774 | 6742 | 7600 | 7570 | 7540 | 7508 | 7474 | 9189 | 9157 | 9123 | 9088 | 9051 |
| 6.0 | | | | | 6.4 | | | | | 6.7 | | | | | 7.4 | | | | |
| 33 | | | | | 31 | | | | | 30 | | | | | 27 | | | | |
| 198 | | | | | 198 | | | | | 201 | | | | | 200 | | | | |
| 37.5 | | | | | 37.1 | | | | | 37.3 | | | | | 37.2 | | | | |
| 4.55 | | | | | 4.79 | | | | | 4.98 | | | | | 5.51 | | | | |
| 1250 | | | | | 1300 | | | | | 1400 | | | | | 1500 | | | | |
| 28/36 | | | | | 28/36 | | | | | 28/36 | | | | | 30/38 | | | | |
| 1100 | | | | | 1150 | | | | | 1250 | | | | | 1350 | | | | |
| $\phi$33×12 | | | | | $\phi$33×12 | | | | | $\phi$39×12 | | | | | $\phi$39×12 | | | | |
| M30 | | | | | M30 | | | | | M36 | | | | | M36 | | | | |
| 4.4 | | | | | 4.4 | | | | | 4.4 | | | | | 4.4 | | | | |
| 410.8 | | | | | 402.4 | | | | | 400.6 | | | | | 390.2 | | | | |
| 15.1 | 15.2 | 15.3 | 15.4 | 15.4 | 16.2 | 16.3 | 16.4 | 16.5 | 16.6 | 18.0 | 18.1 | 18.2 | 18.3 | 18.4 | 21.0 | 21.0 | 21.1 | 21.2 | 21.3 |
| (65.6) | | | | | (73.6) | | | | | (80.4) | | | | | (89.4) | | | | |
| (0.00,60.0) | | | | | (0.00,60.0) | | | | | (0.00,60.0) | | | | | (0.00,60.0) | | | | |
| (0.43,60.0) | | | | | (0.98,60.0) | | | | | (1.40,60.0) | | | | | (2.01,60.0) | | | | |
| (4.00,13.7) | | | | | (4.00,18.3) | | | | | (4.00,22.2) | | | | | (4.00,30.9) | | | | |
| 3800 | | | | | 4210 | | | | | 4610 | | | | | 5600 | | | | |
| $13.0^{+2.0}_{-3.0}$ | | | | | $13.0^{+2.0}_{-3.0}$ | | | | | $15.0^{+0.0}_{-5.0}$ | | | | | $15.0^{+0.0}_{-5.0}$ | | | | |
| 8000 | 7960 | 7930 | 7890 | 7850 | 8920 | 8880 | 8850 | 8810 | 8760 | 11400 | 11400 | 11300 | 11300 | 11200 | 13800 | 13700 | 13700 | 13600 | 13600 |
| 1.0 | | | | | 1.0 | | | | | 1.0 | | | | | 1.0 | | | | |
| 16.3 | 16.4 | 16.4 | 16.4 | 16.5 | 18.2 | 18.2 | 18.2 | 18.3 | 18.3 | 19.9 | 19.9 | 20.0 | 20.0 | 20.0 | 24.2 | 24.3 | 24.3 | 24.3 | 24.4 |
| 1.26 | 1.26 | 1.26 | 1.27 | 1.27 | 1.40 | 1.40 | 1.40 | 1.41 | 1.41 | 1.53 | 1.53 | 1.54 | 1.54 | 1.54 | 1.86 | 1.87 | 1.87 | 1.87 | 1.88 |
| 160 | 181 | 203 | 226 | 250 | 181 | 203 | 226 | 250 | 276 | 203 | 226 | 250 | 276 | 303 | 250 | 276 | 303 | 331 | 360 |
| 2.07 | 2.17 | 2.29 | 2.41 | 2.53 | 2.31 | 2.42 | 2.54 | 2.67 | 2.80 | 2.54 | 2.66 | 2.78 | 2.91 | 3.05 | 3.12 | 3.25 | 3.38 | 3.53 | 3.68 |
| 0.236 | 0.251 | 0.266 | 0.279 | 0.291 | 0.238 | 0.252 | 0.266 | 0.278 | 0.290 | 0.239 | 0.253 | 0.266 | 0.278 | 0.289 | 0.242 | 0.254 | 0.266 | 0.277 | 0.287 |

It will NOT be able to supply our LRB(Lead Rubber Bearing) to 8 countries as China, Taiwan, Korea, Philippines, Malaysia, New Zealand, USA and Italy.

## LH-Series (Total Rabber Thickness 200mm)

| Characteristics | | | LH120G4 | | | | | LH130G4 | | | | | LH140G4 | | | | | LH150G4 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | C | B | A | G | H | C | B | A | G | H | C | B | A | G | H | C | B | A | G | H |
| Physical Dimensions | Outer Diameter (mm) | | 1200 | | | | | 1300 | | | | | 1400 | | | | | 1500 | | | | |
| | Inner Diameter (mm) | | 220 | 230 | 240 | 250 | 260 | 240 | 250 | 260 | 270 | 280 | 260 | 270 | 280 | 290 | 300 | 280 | 290 | 300 | 310 | 320 |
| | Effective Plane Area ($\times 10^2 mm^2$) | | 10930 | 10894 | 10857 | 10819 | 10779 | 12821 | 12782 | 12742 | 12701 | 12657 | 14863 | 14821 | 14778 | 14733 | 14687 | 17056 | 17011 | 16965 | 16917 | 16867 |
| | Thickness of One Rubber Layer (mm) | | 8.0 | | | | | 8.7 | | | | | 9.5 | | | | | 10.0 | | | | |
| | Number of Rubber Layers (–) | | 25 | | | | | 23 | | | | | 21 | | | | | 20 | | | | |
| | Total Rubber Thickness (mm) | | 200 | | | | | 200 | | | | | 200 | | | | | 200 | | | | |
| | First Shape Factor (–) | | 37.5 | | | | | 37.4 | | | | | 36.8 | | | | | 37.5 | | | | |
| | Second Shape Factor (–) | | 6.00 | | | | | 6.50 | | | | | 7.02 | | | | | 7.50 | | | | |
| | Diameter of Flange (mm) | | 1600 | | | | | 1700 | | | | | 1800 | | | | | 1900 | | | | |
| | Thickness of Flange (mm) | | 32/40 | | | | | 32/40 | | | | | 50/100 | | | | | 50/100 | | | | |
| | Diameter of Bolt Center (mm) | | 1450 | | | | | 1550 | | | | | 1650 | | | | | 1700 | | | | |
| | Diameter (Number) of Fixing bolts (mm) | | $\phi$39×12 | | | | | $\phi$39×12 | | | | | $\phi$42×12 | | | | | $\phi$42×12 | | | | |
| | Supposed Bolt (–) | | M36 | | | | | M36 | | | | | M39 | | | | | M39 | | | | |
| | Thickness of One Reinforcing Steel Plate (mm) | | 4.4 | | | | | 4.4 | | | | | 5.8 | | | | | 5.8 | | | | |
| | Height (mm) | | 385.6 | | | | | 376.9 | | | | | 515.5 | | | | | 510.2 | | | | |
| | Total Weight (KN) | | 24.3 | 24.4 | 24.5 | 24.6 | 24.7 | 27.2 | 27.3 | 27.4 | 27.5 | 27.6 | 52.2 | 52.4 | 52.6 | 52.7 | 52.9 | 57.7 | 57.8 | 58.0 | 58.2 | 58.4 |
| Compression Properties | Critical Stress ($N/mm^2$) | $\gamma$=0 $\sigma_{cr}$ | (97.8) | | | | | (106) | | | | | (114) | | | | | (122) | | | | |
| | Ultimate Compressive Stress ($N/mm^2$) | ($\gamma_0, \sigma_0$) | (0.00,60.0) | | | | | (0.00,60.0) | | | | | (0.00,60.0) | | | | | (0.00,60.0) | | | | |
| | | ($\gamma_1, \sigma_1$) | (2.58,60.0) | | | | | (3.12,60.0) | | | | | (3.68,60.0) | | | | | – | | | | |
| | | ($\gamma_2, \sigma_2$) | (4.00,39.1) | | | | | (4.00,47.1) | | | | | (4.00,55.3) | | | | | (4.00,60.3) | | | | |
| | Compressive Stiffness ($\times 10^3 kN/m$) | | 6690 | | | | | 7830 | | | | | 9060 | | | | | 10400 | | | | |
| | Nominal Long Term Compressive Stress ($N/mm^2$) | | 15.0 $^{+0.0}_{-5.0}$ | | | | | 15.0 $^{+0.0}_{-5.0}$ | | | | | 15.0 $^{+0.0}_{-5.0}$ | | | | | 15.0 $^{+0.0}_{-5.0}$ | | | | |
| | Nominal Long Term Column Load (kN) | | 16400 | 16300 | 16300 | 16200 | 16200 | 19200 | 19200 | 19100 | 19100 | 19000 | 22300 | 22200 | 22200 | 22100 | 22000 | 25600 | 25500 | 25400 | 25400 | 25300 |
| | Allowable Tensile Stress ($\gamma$ =100%) ($N/mm^2$) | | 1.0 | | | | | 1.0 | | | | | 1.0 | | | | | 1.0 | | | | |
| Shear Properties ($\gamma$ =100%) | Initial Stiffness ($\times 10^3 kN/m$) | | 28.8 | 28.8 | 28.9 | 28.9 | 29.0 | 33.8 | 33.8 | 33.9 | 33.9 | 34.0 | 39.3 | 39.4 | 39.4 | 39.5 | 39.5 | 45.0 | 45.1 | 45.1 | 45.2 | 45.3 |
| | Post Yield Stiffness ($\gamma$ =100%) ($\times 10^3 kN/m$) | | 2.21 | 2.22 | 2.22 | 2.23 | 2.23 | 2.60 | 2.60 | 2.61 | 2.61 | 2.61 | 3.02 | 3.03 | 3.03 | 3.04 | 3.04 | 3.46 | 3.47 | 3.47 | 3.48 | 3.48 |
| | Characteristic Strength (kN) | | 303 | 331 | 360 | 391 | 423 | 360 | 391 | 423 | 456 | 491 | 423 | 456 | 491 | 526 | 563 | 491 | 526 | 563 | 601 | 641 |
| | Equivalent shear stiffness($\times 10^3 kN/m$) | | 3.73 | 3.87 | 4.02 | 4.18 | 4.34 | 4.40 | 4.56 | 4.72 | 4.89 | 5.07 | 5.14 | 5.31 | 5.49 | 5.67 | 5.86 | 5.92 | 6.10 | 6.29 | 6.48 | 6.68 |
| | Equivalent Damping Ratio (–) | | 0.244 | 0.255 | 0.266 | 0.276 | 0.285 | 0.246 | 0.256 | 0.266 | 0.275 | 0.284 | 0.247 | 0.257 | 0.266 | 0.275 | 0.283 | 0.248 | 0.257 | 0.266 | 0.274 | 0.282 |

It will NOT be able to supply our LRB(Lead Rubber Bearing) to 8 countries as China, Taiwan, Korea, Philippines, Malaysia, New Zealand, USA and Italy.

## LL-Series (Total Rabber Thickness 160mm)

**Code**

| Designation | Compound | Shear Modulus ($N/mm^2$) |
|---|---|---|
| G4 | G0.40 | 0.385 |

| Characteristics | | | LL060G4 | | | | | LL065G4 | | | | | LL070G4 | | | | | LL075G4 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | C | B | A | G | H | C | B | A | G | H | C | B | A | G | H | C | B | A | G | H |
| Physical Dimensions | Outer Diameter (mm) | | 600 | | | | | 650 | | | | | 700 | | | | | 750 | | | | |
| | Inner diameter (mm) | | 100 | 110 | 120 | 130 | 140 | 110 | 120 | 130 | 140 | 150 | 120 | 130 | 140 | 150 | 160 | 130 | 140 | 150 | 160 | 170 |
| | Effective Plane Area ($\times 10^2 mm^2$) | | 2749 | 2732 | 2714 | 2695 | 2673 | 3223 | 3205 | 3186 | 3164 | 3142 | 3735 | 3716 | 3695 | 3672 | 3647 | 4285 | 4264 | 4241 | 4217 | 4191 |
| | Thickness of One Rubber Layer (mm) | | 3.95 | | | | | 4.4 | | | | | 4.9 | | | | | 4.85 | | | | |
| | Number of Rubber Layers (–) | | 41 | | | | | 37 | | | | | 34 | | | | | 34 | | | | |
| | Total Rubber Thickness (mm) | | 162 | | | | | 163 | | | | | 167 | | | | | 165 | | | | |
| | First Shape Factor (–) | | 38.0 | | | | | 36.9 | | | | | 35.7 | | | | | 38.7 | | | | |
| | Second Shape Factor (–) | | 3.70 | | | | | 3.99 | | | | | 4.20 | | | | | 4.55 | | | | |
| | Diameter of Flange (mm) | | 900 | | | | | 950 | | | | | 1000 | | | | | 1100 | | | | |
| | Thickness of Flange (mm) | | 22/28 | | | | | 22/28 | | | | | 22/28 | | | | | 22/28 | | | | |
| | Diameter of Bolt Center (mm) | | 775 | | | | | 825 | | | | | 875 | | | | | 950 | | | | |
| | Diameter (Number) of Fixing bolts (mm) | | $\phi$33×12 | | | | | $\phi$33×12 | | | | | $\phi$33×12 | | | | | $\phi$33×12 | | | | |
| | Supposed Bolt (–) | | M30 | | | | | M30 | | | | | M30 | | | | | M30 | | | | |
| | Thickness of One Reinforcing Steel Plate (mm) | | 3.1 | | | | | 3.1 | | | | | 3.1 | | | | | 3.1 | | | | |
| | Height (mm) | | 342.0 | | | | | 330.4 | | | | | 324.9 | | | | | 323.2 | | | | |
| | Total Weight (KN) | | 5.9 | 5.9 | 6.0 | 6.0 | 6.1 | 6.5 | 6.5 | 6.6 | 6.6 | 6.7 | 7.1 | 7.2 | 7.2 | 7.3 | 7.3 | 8.3 | 8.3 | 8.4 | 8.4 | 8.5 |
| Compression Properties | Critical Stress ($N/mm^2$) | $\gamma=0$ $\sigma_{cr}$ | (41.0) | | | | | (48.4) | | | | | (53.7) | | | | | (66.5) | | | | |
| | Ultimate Compressive Stress ($N/mm^2$) | ($\gamma_0, \sigma_0$) | (0.00,41.0) | | | | | (0.00,48.4) | | | | | (0.00,53.7) | | | | | (0.00,60.0) | | | | |
| | | ($\gamma_1, \sigma_1$) | – | | | | | – | | | | | – | | | | | (0.50,60.0) | | | | |
| | | ($\gamma_2, \sigma_2$) | (3.70,4.10) | | | | | (3.99,4.84) | | | | | (4.00,7.69) | | | | | (4.00,13.9) | | | | |
| | Compressive Stiffness ($\times 10^3 kN/m$) | | 2070 | | | | | 2400 | | | | | 2680 | | | | | 3200 | | | | |
| | Nominal Long Term Compressive Stress ($N/mm^2$) | | 9.2 $^{+1.4}_{-2.1}$ | | | | | 10.5 $^{+1.6}_{-2.4}$ | | | | | 11.4 $^{+1.7}_{-2.6}$ | | | | | 13.0 $^{+2.0}_{-3.0}$ | | | | |
| | Nominal Long Term Column Load (kN) | | 2530 | 2510 | 2500 | 2480 | 2460 | 3380 | 3370 | 3340 | 3320 | 3300 | 4260 | 4240 | 4210 | 4190 | 4160 | 5570 | 5540 | 5510 | 5480 | 5450 |
| | Allowable Tensile Stress ($\gamma$ =100%) ($N/mm^2$) | | 1.0 | | | | | 1.0 | | | | | 1.0 | | | | | 1.0 | | | | |
| Shear Properties ($\gamma$ =100%) | Initial Stiffness ($\times 10^3 kN/m$) | | 8.86 | 8.89 | 8.92 | 8.95 | 8.98 | 10.4 | 10.4 | 10.4 | 10.4 | 10.5 | 11.7 | 11.8 | 11.8 | 11.8 | 11.9 | 13.6 | 13.6 | 13.7 | 13.7 | 13.8 |
| | Post Yield Stiffness ($\gamma$ =100%) ($\times 10^3 kN/m$) | | 0.682 | 0.684 | 0.686 | 0.688 | 0.691 | 0.796 | 0.798 | 0.801 | 0.803 | 0.806 | 0.903 | 0.905 | 0.908 | 0.910 | 0.913 | 1.05 | 1.05 | 1.05 | 1.06 | 1.06 |
| | Characteristic Strength (kN) | | 63 | 76 | 90 | 106 | 123 | 76 | 90 | 106 | 123 | 141 | 90 | 106 | 123 | 141 | 160 | 106 | 123 | 141 | 160 | 181 |
| | Equivalent shear stiffness ($\times 10^3 kN/m$) | | 1.07 | 1.15 | 1.24 | 1.34 | 1.45 | 1.26 | 1.35 | 1.45 | 1.56 | 1.67 | 1.44 | 1.54 | 1.64 | 1.76 | 1.87 | 1.69 | 1.79 | 1.91 | 2.03 | 2.16 |
| | Equivalent Damping Ratio (–) | | 0.219 | 0.244 | 0.266 | 0.285 | 0.302 | 0.223 | 0.246 | 0.266 | 0.284 | 0.300 | 0.227 | 0.247 | 0.266 | 0.283 | 0.298 | 0.229 | 0.248 | 0.266 | 0.282 | 0.296 |

It will NOT be able to supply our LRB(Lead Rubber Bearing) to 8 countries as China, Taiwan, Korea, Philippines, Malaysia, New Zealand, USA and Italy.

## LL-Series (Total Rabber Thickness 160mm)

**Code**

| Designation | Compound | Shear Modulus ($N/mm^2$) |
|---|---|---|
| G4 | G0.40 | 0.385 |

| Characteristics | | | LL080G4 | | | | | LL085G4 | | | | | LL090G4 | | | | | LL095G4 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | C | B | A | G | H | C | B | A | G | H | C | B | A | G | H | C | B | A | G | H |
| Physical Dimensions | Outer Diameter (mm) | | 800 | | | | | 850 | | | | | 900 | | | | | 950 | | | | |
| | Inner diameter (mm) | | 140 | 150 | 160 | 170 | 180 | 150 | 160 | 170 | 180 | 190 | 160 | 170 | 180 | 190 | 200 | 170 | 180 | 190 | 200 | 210 |
| | Effective Plane Area ($\times 10^2 mm^2$) | | 4873 | 4850 | 4825 | 4800 | 4772 | 5498 | 5473 | 5448 | 5420 | 5391 | 6161 | 6135 | 6107 | 6078 | 6048 | 6861 | 6834 | 6805 | 6774 | 6742 |
| | Thickness of One Rubber Layer (mm) | | 5.1 | | | | | 5.25 | | | | | 5.65 | | | | | 6.00 | | | | |
| | Number of Rubber Layers (–) | | 33 | | | | | 32 | | | | | 30 | | | | | 28 | | | | |
| | Total Rubber Thickness (mm) | | 168 | | | | | 168 | | | | | 170 | | | | | 168 | | | | |
| | First Shape Factor (–) | | 39.2 | | | | | 40.5 | | | | | 39.8 | | | | | 39.6 | | | | |
| | Second Shape Factor (–) | | 4.75 | | | | | 5.06 | | | | | 5.31 | | | | | 5.65 | | | | |
| | Diameter of Flange (mm) | | 1150 | | | | | 1200 | | | | | 1250 | | | | | 1300 | | | | |
| | Thickness of Flange (mm) | | 24/32 | | | | | 24/32 | | | | | 28/36 | | | | | 28/36 | | | | |
| | Diameter of Bolt Center (mm) | | 1000 | | | | | 1050 | | | | | 1100 | | | | | 1150 | | | | |
| | Diameter (Number) of Fixing bolts (mm) | | $\phi$33×12 | | | | | $\phi$33×12 | | | | | $\phi$33×12 | | | | | $\phi$33×12 | | | | |
| | Supposed Bolt (–) | | M30 | | | | | M30 | | | | | M30 | | | | | M30 | | | | |
| | Thickness of One Reinforcing Steel Plate (mm) | | 4.4 | | | | | 4.4 | | | | | 4.4 | | | | | 4.4 | | | | |
| | Height (mm) | | 373.1 | | | | | 368.4 | | | | | 369.1 | | | | | 358.8 | | | | |
| | Total Weight (KN) | | 11.4 | 11.4 | 11.5 | 11.6 | 11.6 | 12.5 | 12.5 | 12.6 | 12.7 | 12.8 | 14.2 | 14.2 | 14.3 | 14.4 | 14.5 | 15.1 | 15.1 | 15.2 | 15.3 | 15.3 |
| Compression Properties | Critical Stress ($N/mm^2$) | $\gamma$=0 $\sigma_{cr}$ | (74.0) | | | | | (84.9) | | | | | (88.6) | | | | | (94.1) | | | | |
| | Ultimate Compressive Stress ($N/mm^2$) | ($\gamma_0, \sigma_0$) | (0.00,60.0) | | | | | (0.00,60.0) | | | | | (0.00,60.0) | | | | | (0.00,60.0) | | | | |
| | | ($\gamma_1, \sigma_1$) | (1.00,60.0) | | | | | (1.65,60.0) | | | | | (1.90,60.0) | | | | | (2.28,60.0) | | | | |
| | | ($\gamma_2, \sigma_2$) | (4.00,17.9) | | | | | (4.00,24.5) | | | | | (4.00,28.5) | | | | | (4.0,34.2) | | | | |
| | Compressive Stiffness ($\times 10^3 kN/m$) | | 3590 | | | | | 4100 | | | | | 4530 | | | | | 5080 | | | | |
| | Nominal Long Term Compressive Stress ($N/mm^2$) | | 13.0 $^{+2.0}_{-3.0}$ | | | | | 15.0 $^{+0.0}_{-5.0}$ | | | | | 15.0 $^{+0.0}_{-5.0}$ | | | | | 15.0 $^{+0.0}_{-5.0}$ | | | | |
| | Nominal Long Term Column Load (kN) | | 6330 | 6300 | 6270 | 6240 | 6200 | 8250 | 8210 | 8170 | 8130 | 8090 | 9240 | 9200 | 9160 | 9120 | 9070 | 10300 | 10300 | 10200 | 10200 | 10100 |
| | Allowable Tensile Stress ($\gamma$ =100%) ($N/mm^2$) | | 1.0 | | | | | 1.0 | | | | | 1.0 | | | | | 1.0 | | | | |
| Shear Properties ($\gamma$ =100%) | Initial Stiffness ($\times 10^3 kN/m$) | | 15.2 | 15.2 | 15.3 | 15.3 | 15.3 | 17.2 | 17.2 | 17.3 | 17.3 | 17.3 | 19.1 | 19.1 | 19.2 | 19.2 | 19.3 | 21.5 | 21.5 | 21.6 | 21.6 | 21.6 |
| | Post Yield Stiffness ($\gamma$ =100%) ($\times 10^3 kN/m$) | | 1.17 | 1.17 | 1.17 | 1.18 | 1.18 | 1.32 | 1.32 | 1.33 | 1.33 | 1.33 | 1.47 | 1.47 | 1.47 | 1.48 | 1.48 | 1.65 | 1.65 | 1.66 | 1.66 | 1.67 |
| | Characteristic Strength (kN) | | 123 | 141 | 160 | 181 | 203 | 141 | 160 | 181 | 203 | 226 | 160 | 181 | 203 | 226 | 250 | 181 | 203 | 226 | 250 | 276 |
| | Equivalent shear stiffness($\times 10^3 kN/m$) | | 1.90 | 2.01 | 2.13 | 2.25 | 2.38 | 2.16 | 2.28 | 2.40 | 2.54 | 2.68 | 2.41 | 2.54 | 2.67 | 2.81 | 2.96 | 2.73 | 2.86 | 3.00 | 3.15 | 3.31 |
| | Equivalent Damping Ratio (–) | | 0.232 | 0.250 | 0.266 | 0.281 | 0.294 | 0.234 | 0.251 | 0.266 | 0.280 | 0.293 | 0.236 | 0.251 | 0.266 | 0.279 | 0.291 | 0.238 | 0.252 | 0.266 | 0.278 | 0.290 |

It will NOT be able to supply our LRB(Lead Rubber Bearing) to 8 countries as China, Taiwan, Korea, Philippines, Malaysia, New Zealand, USA and Italy.

## ● LL-Series (Total Rabber Thickness 160mm)

| LL100G4 | | | | | LL110G4 | | | | | LL120G4 | | | | | LL130G4 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | B | A | G | H | C | B | A | G | H | C | B | A | G | H | C | B | A | G | H |
| 1000 | | | | | 1100 | | | | | 1200 | | | | | 1300 | | | | |
| 180 | 190 | 200 | 210 | 220 | 200 | 210 | 220 | 230 | 240 | 220 | 230 | 240 | 250 | 260 | 240 | 250 | 260 | 270 | 280 |
| 7600 | 7570 | 7540 | 7508 | 7474 | 9189 | 9157 | 9123 | 9088 | 9051 | 10930 | 10894 | 10857 | 10819 | 10779 | 12821 | 12782 | 12742 | 12701 | 12657 |
| 6.35 | | | | | 7.2 | | | | | 7.7 | | | | | 8.0 | | | | |
| 26 | | | | | 23 | | | | | 22 | | | | | 21 | | | | |
| 165 | | | | | 166 | | | | | 169 | | | | | 168 | | | | |
| 39.4 | | | | | 38.2 | | | | | 39.0 | | | | | 40.6 | | | | |
| 6.06 | | | | | 6.64 | | | | | 7.08 | | | | | 7.74 | | | | |
| 1400 | | | | | 1500 | | | | | 1600 | | | | | 1700 | | | | |
| 28/36 | | | | | 30/38 | | | | | 32/40 | | | | | 32/40 | | | | |
| 1250 | | | | | 1350 | | | | | 1450 | | | | | 1550 | | | | |
| $\phi$39×12 | | | | | $\phi$39×12 | | | | | $\phi$39×12 | | | | | $\phi$39×12 | | | | |
| M36 | | | | | M36 | | | | | M36 | | | | | M36 | | | | |
| 4.4 | | | | | 4.4 | | | | | 4.4 | | | | | 5.8 | | | | |
| 347.1 | | | | | 338.4 | | | | | 341.8 | | | | | 364.0 | | | | |
| 16.5 | 16.6 | 16.7 | 16.7 | 16.8 | 19.2 | 19.2 | 19.3 | 19.4 | 19.5 | 22.7 | 22.7 | 22.8 | 22.9 | 23.0 | 28.6 | 28.6 | 28.8 | 28.9 | 29.0 |
| (101) | | | | | (109) | | | | | (117) | | | | | (130) | | | | |
| (0.00,60.0) | | | | | (0.00,60.0) | | | | | (0.00,60.0) | | | | | (0.00,60.0) | | | | |
| (2.72,60.0) | | | | | (3.32,60.0) | | | | | (3.84,60.0) | | | | | – | | | | |
| (4.00,40.8) | | | | | (4.00,49.9) | | | | | (4.00,57.6) | | | | | (4.00,60.0) | | | | |
| 5720 | | | | | 6830 | | | | | 8000 | | | | | 9600 | | | | |
| 15.0 $^{+0.0}_{-5.0}$ | | | | | 15.0 $^{+0.0}_{-5.0}$ | | | | | 15.0 $^{+0.0}_{-5.0}$ | | | | | 15.0 $^{+0.0}_{-5.0}$ | | | | |
| 11400 | 11400 | 11300 | 11300 | 11200 | 13800 | 13700 | 13700 | 13600 | 13600 | 16400 | 16300 | 16300 | 16200 | 16200 | 19200 | 19200 | 19100 | 19100 | 19000 |
| 1.0 | | | | | 1.0 | | | | | 1.0 | | | | | 1.0 | | | | |
| 24.2 | 24.3 | 24.3 | 24.3 | 24.4 | 29.2 | 29.3 | 29.3 | 29.4 | 29.4 | 34.0 | 34.0 | 34.1 | 34.2 | 34.2 | 40.2 | 40.3 | 40.4 | 40.4 | 40.5 |
| 1.86 | 1.87 | 1.87 | 1.87 | 1.88 | 2.25 | 2.25 | 2.25 | 2.26 | 2.26 | 2.61 | 2.62 | 2.62 | 2.63 | 2.63 | 3.10 | 3.10 | 3.10 | 3.11 | 3.11 |
| 203 | 226 | 250 | 276 | 303 | 250 | 276 | 303 | 331 | 360 | 303 | 331 | 360 | 391 | 423 | 360 | 391 | 423 | 456 | 491 |
| 3.09 | 3.23 | 3.39 | 3.54 | 3.71 | 3.76 | 3.92 | 4.08 | 4.26 | 4.44 | 4.40 | 4.57 | 4.75 | 4.94 | 5.13 | 5.24 | 5.43 | 5.62 | 5.82 | 6.03 |
| 0.239 | 0.253 | 0.266 | 0.278 | 0.289 | 0.242 | 0.254 | 0.266 | 0.277 | 0.287 | 0.244 | 0.255 | 0.266 | 0.276 | 0.285 | 0.246 | 0.256 | 0.266 | 0.275 | 0.284 |

It will NOT be able to supply our LRB(Lead Rubber Bearing) to 8 countries as China, Taiwan, Korea, Philippines, Malaysia, New Zealand, USA and Italy.

## LT-Series (Total Rabber Thickness 250mm)

**Code**

| Designation | Compound | Shear Modulus ($N/mm^2$) |
|---|---|---|
| G4 | G0.40 | 0.385 |

| Characteristics | | | LT090G4 | | | | | LT100G4 | | | | | LT110G4 | | | | | LT120G4 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | C | B | A | G | H | C | B | A | G | H | C | B | A | G | H | C | B | A | G | H |
| Physical Dimensions | Outer Diameter (mm) | | 900 | | | | | 1000 | | | | | 1100 | | | | | 1200 | | | | |
| | Inner diameter (mm) | | 160 | 170 | 180 | 190 | 200 | 180 | 190 | 200 | 210 | 220 | 200 | 210 | 220 | 230 | 240 | 220 | 230 | 240 | 250 | 260 |
| | Effective Plane Area ($\times 10^2 mm^2$) | | 6161 | 6135 | 6107 | 6078 | 6048 | 7600 | 7570 | 7540 | 7508 | 7474 | 9189 | 9157 | 9123 | 9088 | 9051 | 10930 | 10894 | 10857 | 10819 | 10779 |
| | Thickness of One Rubber Layer (mm) | | 6.0 | | | | | 6.7 | | | | | 7.4 | | | | | 8.0 | | | | |
| | Number of Rubber Layers (–) | | 42 | | | | | 37 | | | | | 34 | | | | | 31 | | | | |
| | Total Rubber Thickness (mm) | | 252 | | | | | 248 | | | | | 252 | | | | | 248 | | | | |
| | First Shape Factor (–) | | 37.5 | | | | | 37.3 | | | | | 37.2 | | | | | 37.5 | | | | |
| | Second Shape Factor (–) | | 3.57 | | | | | 4.03 | | | | | 4.37 | | | | | 4.84 | | | | |
| | Diameter of Flange (mm) | | 1250 | | | | | 1400 | | | | | 1500 | | | | | 1600 | | | | |
| | Thickness of Flange (mm) | | 28/36 | | | | | 28/36 | | | | | 30/38 | | | | | 32/40 | | | | |
| | Diameter of Bolt Center (mm) | | 1100 | | | | | 1250 | | | | | 1350 | | | | | 1450 | | | | |
| | Diameter (Number) of Fixing bolts (mm) | | $\phi$ 33 × 12 | | | | | $\phi$ 39 × 12 | | | | | $\phi$ 39 × 12 | | | | | $\phi$ 39 × 12 | | | | |
| | Supposed Bolt (–) | | M30 | | | | | M36 | | | | | M36 | | | | | M36 | | | | |
| | Thickness of One Reinforcing Steel Plate (mm) | | 4.4 | | | | | 4.4 | | | | | 4.4 | | | | | 4.4 | | | | |
| | Height (mm) | | 504.4 | | | | | 478.3 | | | | | 472.8 | | | | | 460.0 | | | | |
| | Total Weight (KN) | | 17.6 | 17.7 | 17.8 | 17.9 | 18.0 | 20.5 | 20.5 | 20.7 | 20.8 | 20.9 | 24.0 | 24.1 | 24.2 | 24.3 | 24.4 | 27.5 | 27.6 | 27.7 | 27.9 | 28.0 |
| Compression Properties | Critical Stress ($N/mm^2$) | $\gamma$=0 $\sigma_{cr}$ | (37.4) | | | | | (49.8) | | | | | (59.8) | | | | | (75.7) | | | | |
| | Ultimate Compressive Stress ($N/mm^2$) | ($\gamma_0, \sigma_0$) | (0.00,37.4) | | | | | (0.00,49.8) | | | | | (0.00,59.8) | | | | | (0.00,60.0) | | | | |
| | | ($\gamma_1, \sigma_1$) | – | | | | | – | | | | | – | | | | | (1.11,60.0) | | | | |
| | | ($\gamma_2, \sigma_2$) | (3.57,3.74) | | | | | (4.00,5.35) | | | | | (4.00,10.6) | | | | | (4.00,19.4) | | | | |
| | Compressive Stiffness ($\times 10^3 kN/m$) | | 2980 | | | | | 3740 | | | | | 4450 | | | | | 5390 | | | | |
| | Nominal Long Term Compressive Stress ($N/mm^2$) | | 8.6 $^{+1.3}_{-2.0}$ | | | | | 10.7 $^{+1.7}_{-2.5}$ | | | | | 12.2 $^{+1.9}_{-2.8}$ | | | | | 13.0 $^{+2.0}_{-3.0}$ | | | | |
| | Nominal Long Term Column Load (kN) | | 5300 | 5280 | 5250 | 5230 | 5200 | 8130 | 8100 | 8070 | 8030 | 8000 | 11200 | 11200 | 11100 | 11100 | 11000 | 14200 | 14200 | 14100 | 14100 | 14000 |
| | Allowable Tensile Stress ($\gamma$ =100%) ($N/mm^2$) | | 1.0 | | | | | 1.0 | | | | | 1.0 | | | | | 1.0 | | | | |
| Shear Properties ($\gamma$ =100%) | Initial Stiffness ($\times 10^3 kN/m$) | | 12.8 | 12.9 | 12.9 | 12.9 | 13.0 | 16.1 | 16.2 | 16.2 | 16.2 | 16.3 | 19.2 | 19.3 | 19.3 | 19.3 | 19.4 | 23.2 | 23.3 | 23.3 | 23.3 | 23.4 |
| | Post Yield Stiffness ($\gamma$ =100%) ($\times 10^3 kN/m$) | | 0.988 | 0.990 | 0.992 | 0.994 | 0.997 | 1.24 | 1.24 | 1.24 | 1.25 | 1.25 | 1.48 | 1.48 | 1.48 | 1.49 | 1.49 | 1.79 | 1.79 | 1.79 | 1.79 | 1.80 |
| | Characteristic Strength (kN) | | 160 | 181 | 203 | 226 | 250 | 203 | 226 | 250 | 276 | 303 | 250 | 276 | 303 | 331 | 360 | 303 | 331 | 360 | 391 | 423 |
| | Equivalent shear stiffness($\times 10^3 kN/m$) | | 1.62 | 1.71 | 1.80 | 1.89 | 1.99 | 2.06 | 2.15 | 2.25 | 2.36 | 2.47 | 2.47 | 2.58 | 2.69 | 2.80 | 2.92 | 3.01 | 3.12 | 3.25 | 3.37 | 3.50 |
| | Equivalent Damping Ratio (–) | | 0.236 | 0.251 | 0.266 | 0.279 | 0.291 | 0.239 | 0.253 | 0.266 | 0.278 | 0.289 | 0.242 | 0.254 | 0.266 | 0.277 | 0.287 | 0.244 | 0.255 | 0.266 | 0.276 | 0.285 |

It will NOT be able to supply our LRB(Lead Rubber Bearing) to 8 countries as China, Taiwan, Korea, Philippines, Malaysia, New Zealand, USA and Italy.

## ● LT-Series (Total Rabber Thickness 250mm)

| LT130G4 | | | | | LT140G4 | | | | | LT150G4 | | | | | LT160G4 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | B | A | G | H | C | B | A | G | H | C | B | A | G | H | C | B | A | G | H |
| 1300 | | | | | 1400 | | | | | 1500 | | | | | 1600 | | | | |
| 240 | 250 | 260 | 270 | 280 | 260 | 270 | 280 | 290 | 300 | 280 | 290 | 300 | 310 | 320 | 300 | 310 | 320 | 330 | 340 |
| 12821 | 12782 | 12742 | 12701 | 12657 | 14863 | 14821 | 14778 | 14733 | 14687 | 17056 | 17011 | 16965 | 16917 | 16867 | 19399 | 19351 | 19302 | 19251 | 19198 |
| 8.7 | | | | | 9.5 | | | | | 10.0 | | | | | 10.4 | | | | |
| 29 | | | | | 26 | | | | | 25 | | | | | 24 | | | | |
| 252 | | | | | 247 | | | | | 250 | | | | | 250 | | | | |
| 37.4 | | | | | 36.8 | | | | | 37.5 | | | | | 38.5 | | | | |
| 5.15 | | | | | 5.67 | | | | | 6.00 | | | | | 6.41 | | | | |
| 1700 | | | | | 1800 | | | | | 1900 | | | | | 2000 | | | | |
| 32/40 | | | | | 50/100 | | | | | 50/100 | | | | | 50/110 | | | | |
| 1550 | | | | | 1650 | | | | | 1700 | | | | | 1800 | | | | |
| $\phi$39×12 | | | | | $\phi$42×12 | | | | | $\phi$42×12 | | | | | $\phi$45×12 | | | | |
| M36 | | | | | M39 | | | | | M39 | | | | | M42 | | | | |
| 4.4 | | | | | 5.8 | | | | | 5.8 | | | | | 5.8 | | | | |
| 455.5 | | | | | 592.0 | | | | | 589.2 | | | | | 603 | | | | |
| 31.0 | 31.1 | 31.3 | 31.4 | 31.5 | 56.5 | 56.6 | 56.9 | 57.1 | 57.3 | 63.5 | 63.6 | 63.9 | 64.1 | 64.3 | 74.2 | 74.3 | 74.6 | 74.9 | 75.1 |
| (83.8) | | | | | (91.7) | | | | | (97.8) | | | | | (106) | | | | |
| (0.00,60.0) | | | | | (0.00,60.0) | | | | | (0.00,60.0) | | | | | (0.00,60.0) | | | | |
| (1.63,60.0) | | | | | (2.18,60.0) | | | | | (2.58,60.0) | | | | | (3.07,60.0) | | | | |
| (4.00,25.3) | | | | | (4.00,33.5) | | | | | (4.00,39.1) | | | | | (4.00,46.3) | | | | |
| 6210 | | | | | 7320 | | | | | 8360 | | | | | 9610 | | | | |
| 15.0 $^{+0.0}_{-5.0}$ | | | | | 15.0 $^{+0.0}_{-5.0}$ | | | | | 15.0 $^{+0.0}_{-5.0}$ | | | | | 15.0 $^{+0.0}_{-5.0}$ | | | | |
| 19200 | 19200 | 19100 | 19100 | 19000 | 22300 | 22200 | 22200 | 22100 | 22000 | 25600 | 25500 | 25400 | 25400 | 25300 | 29100 | 29000 | 29000 | 28900 | 28800 |
| 1.0 | | | | | 1.0 | | | | | 1.0 | | | | | 1.0 | | | | |
| 26.8 | 26.8 | 26.9 | 26.9 | 27.0 | 31.7 | 31.8 | 31.8 | 31.9 | 31.9 | 36.0 | 36.1 | 36.1 | 36.2 | 36.2 | 41.0 | 41.1 | 41.1 | 41.2 | 41.3 |
| 2.06 | 2.06 | 2.07 | 2.07 | 2.07 | 2.44 | 2.45 | 2.45 | 2.45 | 2.46 | 2.77 | 2.77 | 2.78 | 2.78 | 2.79 | 3.16 | 3.16 | 3.17 | 3.17 | 3.17 |
| 360 | 391 | 423 | 456 | 491 | 423 | 456 | 491 | 526 | 563 | 491 | 526 | 563 | 601 | 641 | 563 | 601 | 641 | 681 | 723 |
| 3.49 | 3.61 | 3.74 | 3.88 | 4.02 | 4.15 | 4.29 | 4.44 | 4.58 | 4.74 | 4.73 | 4.88 | 5.03 | 5.19 | 5.35 | 5.41 | 5.57 | 5.73 | 5.90 | 6.07 |
| 0.246 | 0.256 | 0.266 | 0.275 | 0.284 | 0.247 | 0.257 | 0.266 | 0.275 | 0.283 | 0.248 | 0.257 | 0.266 | 0.274 | 0.282 | 0.250 | 0.258 | 0.266 | 0.273 | 0.281 |

It will NOT be able to supply our LRB(Lead Rubber Bearing) to 8 countries as China, Taiwan, Korea, Philippines, Malaysia, New Zealand, USA and Italy.

## ● LS-Series ($S_2$ = 5type)

**Code**

| Designation | Compound | Shear Modulus ($N/mm^2$) |
|---|---|---|
| G4 | G0.40 | 0.385 |

| Characteristics | | | LS060G4 | | | | | LS065G4 | | | | | LS070G4 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | C | B | A | G | H | C | B | A | G | H | C | B | A | G | H |
| Physical Dimensions | Outer Diameter (mm) | | 600 | | | | | 650 | | | | | 700 | | | | |
| | Inner diameter (mm) | | 100 | 110 | 120 | 130 | 140 | 110 | 120 | 130 | 140 | 150 | 120 | 130 | 140 | 150 | 160 |
| | Effective Plane Area ($\times 10^2 mm^2$) | | 2749 | 2732 | 2714 | 2695 | 2673 | 3223 | 3205 | 3186 | 3164 | 3142 | 3735 | 3716 | 3695 | 3672 | 3647 |
| | Thickness of One Rubber Layer (mm) | | 4.0 | | | | | 4.4 | | | | | 4.7 | | | | |
| | Number of Rubber Layers (–) | | 30 | | | | | 30 | | | | | 30 | | | | |
| | Total Rubber Thickness (mm) | | 120 | | | | | 132 | | | | | 141 | | | | |
| | First Shape Factor (–) | | 37.5 | | | | | 36.9 | | | | | 37.2 | | | | |
| | Second Shape Factor (–) | | 5.00 | | | | | 4.92 | | | | | 4.96 | | | | |
| | Diameter of Flange (mm) | | 900 | | | | | 950 | | | | | 1000 | | | | |
| | Thickness of Flange (mm) | | 22/28 | | | | | 22/28 | | | | | 22/28 | | | | |
| | Diameter of Bolt Center (mm) | | 775 | | | | | 825 | | | | | 875 | | | | |
| | Diameter (Number) of Fixing bolts (mm) | | $\phi$33×12 | | | | | $\phi$33×12 | | | | | $\phi$33×12 | | | | |
| | Supposed Bolt (–) | | M30 | | | | | M30 | | | | | M30 | | | | |
| | Thickness of One Reinforcing Steel Plate (mm) | | 3.1 | | | | | 3.1 | | | | | 3.1 | | | | |
| | Height (mm) | | 265.9 | | | | | 277.9 | | | | | 286.9 | | | | |
| | Total Weight (KN) | | 5.0 | 5.0 | 5.0 | 5.1 | 5.1 | 5.8 | 5.8 | 5.8 | 5.9 | 5.9 | 6.6 | 6.6 | 6.7 | 6.7 | 6.8 |
| Compression Properties | Critical Stress ($N/mm^2$) | $\gamma$=0 $\sigma_{cr}$ | (81.5) | | | | | (78.2) | | | | | (79.9) | | | | |
| | Ultimate Compressive Stress ($N/mm^2$) | ($\gamma_0, \sigma_0$) | (0.00,60.0) | | | | | (0.00,60.0) | | | | | (0.00,60.0) | | | | |
| | | ($\gamma_1, \sigma_1$) | (1.46,60.0) | | | | | (1.28,60.0) | | | | | (1.38,60.0) | | | | |
| | | ($\gamma_2, \sigma_2$) | (4.00,22.8) | | | | | (4.00,21.0) | | | | | (4.00,22.0) | | | | |
| | Compressive Stiffness ($\times 10^3 kN/m$) | | 2790 | | | | | 2960 | | | | | 3220 | | | | |
| | Nominal Long Term Compressive Stress ($N/mm^2$) | | 15.0 $^{+0.0}_{-5.0}$ | | | | | 15.0 $^{+0.0}_{-5.0}$ | | | | | 15.0 $^{+0.0}_{-5.0}$ | | | | |
| | Nominal Long Term Column Load (kN) | | 4120 | 4100 | 4070 | 4040 | 4010 | 4830 | 4810 | 4780 | 4750 | 4710 | 5600 | 5570 | 5540 | 5510 | 5470 |
| | Allowable Tensile Stress ($\gamma$ =100%) ($N/mm^2$) | | 1.0 | | | | | 1.0 | | | | | 1.0 | | | | |
| Shear Properties ($\gamma$ =100%) | Initial Stiffness ($\times 10^3 kN/m$) | | 12.0 | 12.0 | 12.0 | 12.1 | 12.1 | 12.8 | 12.8 | 12.8 | 12.9 | 12.9 | 13.9 | 13.9 | 13.9 | 14.0 | 14.0 |
| | Post Yield Stiffness ($\gamma$ =100%) ($\times 10^3 kN/m$) | | 0.920 | 0.923 | 0.926 | 0.929 | 0.933 | 0.982 | 0.985 | 0.988 | 0.991 | 0.994 | 1.07 | 1.07 | 1.07 | 1.08 | 1.08 |
| | Characteristic Strength (kN) | | 63 | 76 | 90 | 106 | 123 | 76 | 90 | 106 | 123 | 141 | 90 | 106 | 123 | 141 | 160 |
| | Equivalent shear stiffness ($\times 10^3 kN/m$) | | 1.44 | 1.55 | 1.68 | 1.81 | 1.95 | 1.56 | 1.67 | 1.79 | 1.92 | 2.06 | 1.71 | 1.82 | 1.94 | 2.07 | 2.22 |
| | Equivalent Damping Ratio (–) | | 0.219 | 0.244 | 0.266 | 0.285 | 0.302 | 0.223 | 0.246 | 0.266 | 0.284 | 0.300 | 0.227 | 0.247 | 0.266 | 0.283 | 0.298 |

It will NOT be able to supply our LRB(Lead Rubber Bearing) to 8 countries as China, Taiwan, Korea, Philippines, Malaysia, New Zealand, USA and Italy.

## ● LS-Series ($S_2$ = 5type)

| LS075G4 | | | | | LS080G4 | | | | | LS085G4 | | | | | LS090G4 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | B | A | G | H | C | B | A | G | H | C | B | A | G | H | C | B | A | G | H |
| 750 | | | | | 800 | | | | | 850 | | | | | 900 | | | | |
| 130 | 140 | 150 | 160 | 170 | 140 | 150 | 160 | 170 | 180 | 150 | 160 | 170 | 180 | 190 | 160 | 170 | 180 | 190 | 200 |
| 4285 | 4264 | 4241 | 4217 | 4191 | 4873 | 4850 | 4825 | 4800 | 4772 | 5498 | 5473 | 5448 | 5420 | 5391 | 6161 | 6135 | 6107 | 6078 | 6048 |
| 5.0 | | | | | 5.4 | | | | | 5.7 | | | | | 6.0 | | | | |
| 30 | | | | | 30 | | | | | 30 | | | | | 30 | | | | |
| 150 | | | | | 162 | | | | | 171 | | | | | 180 | | | | |
| 37.5 | | | | | 37.0 | | | | | 37.3 | | | | | 37.5 | | | | |
| 5.00 | | | | | 4.94 | | | | | 4.97 | | | | | 5.00 | | | | |
| 1100 | | | | | 1150 | | | | | 1200 | | | | | 1250 | | | | |
| 22/28 | | | | | 24/32 | | | | | 24/32 | | | | | 28/36 | | | | |
| 950 | | | | | 1000 | | | | | 1050 | | | | | 1100 | | | | |
| $\phi$33×12 | | | | | $\phi$33×12 | | | | | $\phi$33×12 | | | | | $\phi$33×12 | | | | |
| M30 | | | | | M30 | | | | | M30 | | | | | M30 | | | | |
| 3.1 | | | | | 4.4 | | | | | 4.4 | | | | | 4.4 | | | | |
| 295.9 | | | | | 353.6 | | | | | 362.6 | | | | | 379.6 | | | | |
| 7.8 | 7.8 | 7.8 | 7.9 | 7.9 | 10.8 | 10.9 | 10.9 | 11.0 | 11.1 | 12.1 | 12.2 | 12.3 | 12.3 | 12.4 | 14.3 | 14.3 | 14.4 | 14.5 | 14.6 |
| (81.5) | | | | | (78.8) | | | | | (80.2) | | | | | (81.5) | | | | |
| (0.00,60.0) | | | | | (0.00,60.0) | | | | | (0.00,60.0) | | | | | (0.00,60.0) | | | | |
| (1.46,60.0) | | | | | (1.31,60.0) | | | | | (1.39,60.0) | | | | | (1.46,60.0) | | | | |
| (4.00,22.8) | | | | | (4.00,21.4) | | | | | (4.00,22.1) | | | | | (4.00,22.8) | | | | |
| 3480 | | | | | 3650 | | | | | 3910 | | | | | 4180 | | | | |
| 15.0 $^{+0.0}_{-5.0}$ | | | | | 15.0 $^{+0.0}_{-5.0}$ | | | | | 15.0 $^{+0.0}_{-5.0}$ | | | | | 15.0 $^{+0.0}_{-5.0}$ | | | | |
| 6430 | 6400 | 6360 | 6330 | 6290 | 7310 | 7270 | 7240 | 7200 | 7160 | 8250 | 8210 | 8170 | 8130 | 8090 | 9240 | 9200 | 9160 | 9120 | 9070 |
| 1.0 | | | | | 1.0 | | | | | 1.0 | | | | | 1.0 | | | | |
| 15.0 | 15.0 | 15.0 | 15.1 | 15.1 | 15.8 | 15.8 | 15.8 | 15.9 | 15.9 | 16.9 | 16.9 | 17.0 | 17.0 | 17.0 | 18.0 | 18.0 | 18.1 | 18.1 | 18.1 |
| 1.15 | 1.15 | 1.16 | 1.16 | 1.16 | 1.21 | 1.22 | 1.22 | 1.22 | 1.23 | 1.30 | 1.30 | 1.30 | 1.31 | 1.31 | 1.38 | 1.39 | 1.39 | 1.39 | 1.40 |
| 106 | 123 | 141 | 160 | 181 | 123 | 141 | 160 | 181 | 203 | 141 | 160 | 181 | 203 | 226 | 160 | 181 | 203 | 226 | 250 |
| 1.86 | 1.97 | 2.10 | 2.23 | 2.37 | 1.97 | 2.09 | 2.21 | 2.34 | 2.48 | 2.12 | 2.24 | 2.36 | 2.49 | 2.63 | 2.27 | 2.39 | 2.51 | 2.65 | 2.79 |
| 0.229 | 0.248 | 0.266 | 0.282 | 0.296 | 0.232 | 0.250 | 0.266 | 0.281 | 0.294 | 0.234 | 0.251 | 0.266 | 0.280 | 0.293 | 0.236 | 0.251 | 0.266 | 0.279 | 0.291 |

It will NOT be able to supply our LRB(Lead Rubber Bearing) to 8 countries as China, Taiwan, Korea, Philippines, Malaysia, New Zealand, USA and Italy.

## ● LS-Series ($S_2$ = 5type)

**Code**

| Designation | Compound | Shear Modulus ($N/mm^2$) |
|---|---|---|
| G4 | G0.40 | 0.385 |

| Characteristics | | | LS095G4 | | | | | LS100G4 | | | | | LS110G4 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | C | B | A | G | H | C | B | A | G | H | C | B | A | G | H |
| Physical Dimensions | Outer Diameter (mm) | | 950 | | | | | 1000 | | | | | 1100 | | | | |
| | Inner diameter (mm) | | 170 | 180 | 190 | 200 | 210 | 180 | 190 | 200 | 210 | 220 | 200 | 210 | 220 | 230 | 240 |
| | Effective Plane Area ($\times 10^2 mm^2$) | | 6861 | 6834 | 6805 | 6774 | 6742 | 7600 | 7570 | 7540 | 7508 | 7474 | 9189 | 9157 | 9123 | 9088 | 9051 |
| | Thickness of One Rubber Layer (mm) | | 6.4 | | | | | 6.7 | | | | | 7.4 | | | | |
| | Number of Rubber Layers (–) | | 30 | | | | | 30 | | | | | 30 | | | | |
| | Total Rubber Thickness (mm) | | 192 | | | | | 201 | | | | | 222 | | | | |
| | First Shape Factor (–) | | 37.1 | | | | | 37.3 | | | | | 37.2 | | | | |
| | Second Shape Factor (–) | | 4.95 | | | | | 4.98 | | | | | 4.95 | | | | |
| | Diameter of Flange (mm) | | 1300 | | | | | 1400 | | | | | 1500 | | | | |
| | Thickness of Flange (mm) | | 28/36 | | | | | 28/36 | | | | | 30/38 | | | | |
| | Diameter of Bolt Center (mm) | | 1150 | | | | | 1250 | | | | | 1350 | | | | |
| | Diameter (Number) of Fixing bolts (mm) | | $\phi$33×12 | | | | | $\phi$39×12 | | | | | $\phi$39×12 | | | | |
| | Supposed Bolt (–) | | M30 | | | | | M36 | | | | | M36 | | | | |
| | Thickness of One Reinforcing Steel Plate (mm) | | 4.4 | | | | | 4.4 | | | | | 4.4 | | | | |
| | Height (mm) | | 391.6 | | | | | 400.6 | | | | | 425.6 | | | | |
| | Total Weight (KN) | | 15.9 | 15.9 | 16.0 | 16.1 | 16.2 | 18.0 | 18.1 | 18.2 | 18.3 | 18.4 | 22.3 | 22.3 | 22.4 | 22.5 | 22.7 |
| Compression Properties | Critical Stress ($N/mm^2$) | $\gamma$=0 $\sigma_{cr}$ | (79.2) | | | | | (80.4) | | | | | (79.5) | | | | |
| | Ultimate Compressive Stress ($N/mm^2$) | ($\gamma_0, \sigma_0$) | (0.00,60.0) | | | | | (0.00,60.0) | | | | | (0.00,60.0) | | | | |
| | | ($\gamma_1, \sigma_1$) | (1.33,60.0) | | | | | (1.40,60.0) | | | | | (1.35,60.0) | | | | |
| | | ($\gamma_2, \sigma_2$) | (4.00,21.6) | | | | | (4.00,22.2) | | | | | (4.00,21.8) | | | | |
| | Compressive Stiffness ($\times 10^3 kN/m$) | | 4350 | | | | | 4610 | | | | | 5040 | | | | |
| | Nominal Long Term Compressive Stress ($N/mm^2$) | | 15.0 $^{+0.0}_{-5.0}$ | | | | | 15.0 $^{+0.0}_{-5.0}$ | | | | | 15.0 $^{+0.0}_{-5.0}$ | | | | |
| | Nominal Long Term Column Load (kN) | | 10300 | 10300 | 10200 | 10200 | 10100 | 11400 | 11400 | 11300 | 11300 | 11200 | 13800 | 13700 | 13700 | 13600 | 13600 |
| | Allowable Tensile Stress ($\gamma$ =100%) ($N/mm^2$) | | 1.0 | | | | | 1.0 | | | | | 1.0 | | | | |
| Shear Properties ($\gamma$ =100%) | Initial Stiffness ($\times 10^3 kN/m$) | | 18.8 | 18.8 | 18.9 | 18.9 | 18.9 | 19.9 | 19.9 | 20.0 | 20.0 | 20.0 | 21.8 | 21.8 | 21.9 | 21.9 | 21.9 |
| | Post Yield Stiffness ($\gamma$ =100%) ($\times 10^3 kN/m$) | | 1.44 | 1.45 | 1.45 | 1.45 | 1.46 | 1.53 | 1.53 | 1.54 | 1.54 | 1.54 | 1.68 | 1.68 | 1.68 | 1.69 | 1.69 |
| | Characteristic Strength (kN) | | 181 | 203 | 226 | 250 | 276 | 203 | 226 | 250 | 276 | 303 | 250 | 276 | 303 | 331 | 360 |
| | Equivalent shear stiffness ($\times 10^3 kN/m$) | | 2.39 | 2.50 | 2.63 | 2.76 | 2.89 | 2.54 | 2.66 | 2.78 | 2.91 | 3.05 | 2.80 | 2.92 | 3.05 | 3.18 | 3.31 |
| | Equivalent Damping Ratio (–) | | 0.238 | 0.252 | 0.266 | 0.278 | 0.290 | 0.239 | 0.253 | 0.266 | 0.278 | 0.289 | 0.242 | 0.254 | 0.266 | 0.277 | 0.287 |

It will NOT be able to supply our LRB(Lead Rubber Bearing) to 8 countries as China, Taiwan, Korea, Philippines, Malaysia, New Zealand, USA and Italy.

## ● LS-Series ($S_2$ = 5type)

| LS120G4 | | | | | LS130G4 | | | | | LS140G4 | | | | | LU150G4 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | B | A | G | H | C | B | A | G | H | C | B | A | G | H | C | B | A | G | H |
| 1200 | | | | | 1300 | | | | | 1400 | | | | | 1500 | | | | |
| 220 | 230 | 240 | 250 | 260 | 240 | 250 | 260 | 270 | 280 | 260 | 270 | 280 | 290 | 300 | 280 | 290 | 300 | 310 | 320 |
| 10930 | 10894 | 10857 | 10819 | 10779 | 12821 | 12782 | 12742 | 12701 | 12657 | 14863 | 14821 | 14778 | 14733 | 14687 | 17056 | 17011 | 16965 | 16917 | 16867 |
| 8.0 | | | | | 8.7 | | | | | 9.3 | | | | | 8.5 | | | | |
| 30 | | | | | 30 | | | | | 30 | | | | | 35 | | | | |
| 240 | | | | | 261 | | | | | 279 | | | | | 298 | | | | |
| 37.5 | | | | | 37.4 | | | | | 37.6 | | | | | 44.1 | | | | |
| 5.00 | | | | | 4.98 | | | | | 5.02 | | | | | 5.04 | | | | |
| 1600 | | | | | 1700 | | | | | 1800 | | | | | 1900 | | | | |
| 32/40 | | | | | 32/40 | | | | | 37/45 | | | | | 50/100 | | | | |
| 1450 | | | | | 1550 | | | | | 1650 | | | | | 1700 | | | | |
| $\phi$39×12 | | | | | $\phi$39×12 | | | | | $\phi$42×12 | | | | | $\phi$42×12 | | | | |
| M36 | | | | | M36 | | | | | M39 | | | | | M39 | | | | |
| 4.4 | | | | | 4.4 | | | | | 5.8 | | | | | 5.8 | | | | |
| 447.6 | | | | | 468.6 | | | | | 537.2 | | | | | 694.7 | | | | |
| 27.0 | 27.1 | 27.2 | 27.3 | 27.4 | 31.6 | 31.7 | 31.9 | 32.0 | 32.2 | 43.6 | 43.7 | 43.9 | 44.1 | 44.2 | 72.3 | 72.5 | 72.8 | 73.0 | 73.3 |
| (81.5) | | | | | (80.6) | | | | | (81.9) | | | | | (87.1) | | | | |
| (0.00,60.0) | | | | | (0.00,60.0) | | | | | (0.00,60.0) | | | | | (0.00,60.0) | | | | |
| (1.46,60.0) | | | | | (1.42,60.0) | | | | | (1.49,60.0) | | | | | (1.75,60.0) | | | | |
| (4.00,22.8) | | | | | (4.00,22.4) | | | | | (4.00,23.1) | | | | | (4.00,24.9) | | | | |
| 5570 | | | | | 6000 | | | | | 6530 | | | | | 7400 | | | | |
| 15.0 +0.0 -5.0 | | | | | 15.0 +0.0 -5.0 | | | | | 15.0 +0.0 -5.0 | | | | | 15.0 +0.0 -5.0 | | | | |
| 16400 | 16300 | 16300 | 16200 | 16200 | 19200 | 19200 | 19100 | 19100 | 19000 | 22300 | 22200 | 22200 | 22100 | 22000 | 25600 | 25500 | 25400 | 25400 | 25300 |
| 1.0 | | | | | 1.0 | | | | | 1.0 | | | | | 1.0 | | | | |
| 24.0 | 24.0 | 24.1 | 24.1 | 24.2 | 25.9 | 25.9 | 26.0 | 26.0 | 26.1 | 28.1 | 28.1 | 28.2 | 28.2 | 28.3 | 30.3 | 30.3 | 30.3 | 30.4 | 30.4 |
| 1.85 | 1.85 | 1.85 | 1.85 | 1.86 | 1.99 | 2.00 | 2.00 | 2.00 | 2.00 | 2.16 | 2.16 | 2.17 | 2.17 | 2.17 | 2.33 | 2.33 | 2.33 | 2.34 | 2.34 |
| 303 | 331 | 360 | 391 | 423 | 360 | 391 | 423 | 456 | 491 | 423 | 456 | 491 | 526 | 563 | 491 | 526 | 563 | 601 | 641 |
| 3.11 | 3.23 | 3.35 | 3.48 | 3.62 | 3.37 | 3.49 | 3.62 | 3.75 | 3.88 | 3.68 | 3.80 | 3.93 | 4.06 | 4.19 | 3.98 | 4.10 | 4.23 | 4.36 | 4.49 |
| 0.244 | 0.255 | 0.266 | 0.276 | 0.285 | 0.246 | 0.256 | 0.266 | 0.275 | 0.284 | 0.247 | 0.257 | 0.266 | 0.275 | 0.283 | 0.248 | 0.257 | 0.266 | 0.274 | 0.282 |

It will NOT be able to supply our LRB(Lead Rubber Bearing) to 8 countries as China, Taiwan, Korea, Philippines, Malaysia, New Zealand, USA and Italy.

# Dimension and Performance Properties of N-RB

## ● NS-Series ($S_2$ = 5type)

**Code**

| Designation | Compound | Shear Modulus (N/mm²) |
|---|---|---|
| N3 | G0.30 | 0.294 |

| Characteristics | | | NS060N3 | NS065N3 | NS070N3 | NS075N3 | NS080N3 | NS085N3 | NS090N3 | NS095N3 | NS100N3 | NS110N3 | NS120N3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Physical Dimensions | Outer Diameter (mm) | | 600 | 650 | 700 | 750 | 800 | 850 | 900 | 950 | 1000 | 1100 | 1200 |
| | Inner Diameter (mm) | | 15 | 15 | 15 | 15 | 20 | 20 | 20 | 20 | 25 | 25 | 25 |
| | Effective Plane Area ($\times 10^2$mm²) | | 2826 | 3317 | 3847 | 4416 | 5023 | 5671 | 6359 | 7085 | 7849 | 9498 | 11305 |
| | Thickness of One Rubber Layer (mm) | | 4.0 | 4.4 | 4.7 | 5.0 | 5.4 | 5.7 | 6.0 | 6.4 | 6.7 | 7.4 | 8.0 |
| | Number of Rubber Layers (—) | | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| | Total Rubber Thickness (mm) | | 120 | 132 | 141 | 150 | 162 | 171 | 180 | 192 | 201 | 222 | 240 |
| | First Shape Factor (—) | | 36.6 | 36.1 | 36.4 | 36.8 | 36.1 | 36.4 | 36.7 | 36.3 | 36.4 | 36.3 | 36.7 |
| | Second Shape Factor (—) | | 5.00 | 4.92 | 4.96 | 5.00 | 4.94 | 4.97 | 5.00 | 4.95 | 4.98 | 4.95 | 5.00 |
| | Diameter of Flange (mm) | | 900 | 950 | 1000 | 1100 | 1150 | 1200 | 1250 | 1300 | 1400 | 1500 | 1600 |
| | Thickness of Flange (mm) | | 22/28 | 22/28 | 22/28 | 22/28 | 24/32 | 24/32 | 28/36 | 28/36 | 28/36 | 30/38 | 32/40 |
| | Diameter of Bolt Center (mm) | | 775 | 825 | 875 | 950 | 1000 | 1050 | 1100 | 1150 | 1250 | 1350 | 1450 |
| | Diameter (Number) of Fixing bolts (mm) | | φ33×12 | φ33×12 | φ33×12 | φ33×12 | φ33×12 | φ33×12 | φ33×12 | φ33×12 | φ39×12 | φ39×12 | φ39×12 |
| | Supposed Bolt (—) | | M30 | M30 | M30 | M30 | M30 | M30 | M30 | M30 | M36 | M36 | M36 |
| | Thickness of One Reinforcing Steel Plate (mm) | | 3.1 | 3.1 | 3.1 | 3.1 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 |
| | Height (mm) | | 265.9 | 277.9 | 286.9 | 295.9 | 353.6 | 362.6 | 379.6 | 391.6 | 400.6 | 425.6 | 447.6 |
| | Total Weight (KN) | | 4.8 | 5.6 | 6.4 | 7.5 | 10.5 | 11.7 | 13.8 | 15.3 | 17.3 | 21.3 | 25.8 |
| Compression Properties | Critical Stress (N/mm²) | $\gamma$=0 $\sigma_{cr}$ | 53 | 51 | 52 | 53 | 51 | 52 | 53 | 52 | 52 | 52 | 53 |
| | Ultimate Compressive Stress (N/mm²) | ($\gamma_0$, $\sigma_0$) | (0,40) | (0,40) | (0,40) | (0,40) | (0,40) | (0,40) | (0,40) | (0,40) | (0,40) | (0,40) | (0,40) |
| | | ($\gamma_1$, $\sigma_1$) | (1.6,40) | (1.4,40) | (1.5,40) | (1.6,40) | (1.4,40) | (1.5,40) | (1.6,40) | (1.5,40) | (1.5,40) | (1.5,40) | (1.6,40) |
| | | ($\gamma_2$, $\sigma_2$) | (4.0,21) | (4.0,19) | (4.0,20) | (4.0,21) | (4.0,19) | (4.0,20) | (4.0,21) | (4.0,20) | (4.0,20) | (4.0,20) | (4.0,21) |
| | Compressive Stiffness ($\times 10^3$kN/m) | | 2140 | 2270 | 2470 | 2680 | 2800 | 3000 | 3210 | 3340 | 3540 | 3870 | 4290 |
| | Nominal Long Term Compressive Stress (N/mm²) | | $10.0^{+1.0}_{-3.0}$ | $10.0^{+1.0}_{-3.0}$ | $10.0^{+1.0}_{-3.0}$ | $10.0^{+1.0}_{-3.0}$ | $10.0^{+1.0}_{-3.0}$ | $10.0^{+1.0}_{-3.0}$ | $10.0^{+1.0}_{-3.0}$ | $10.0^{+1.0}_{-3.0}$ | $10.0^{+1.0}_{-3.0}$ | $10.0^{+1.0}_{-3.0}$ | $10.0^{+1.0}_{-3.0}$ |
| | Nominal Long Term Column Load (kN) | | 2830 | 3320 | 3850 | 4420 | 5020 | 5670 | 6360 | 7090 | 7850 | 9500 | 11300 |
| | Allowable Tensile Stress ($\gamma$ =100%) (N/mm²) | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Shear Properties | Shear Stiffness ($\times 10^3$kN/m) (critical stress : $\gamma = \pm 100\%$) | | 0.693 | 0.739 | 0.803 | 0.866 | 0.912 | 0.976 | 1.04 | 1.09 | 1.15 | 1.26 | 1.39 |

## ● NS-Series ($S_2$ = 5type)

**Code**

| Designation | Compound | Shear Modulus (N/mm$^2$) |
|---|---|---|
| G3 | G0.35 | 0.343 |

| Characteristics | | | NS060G3 | NS065G3 | NS070G3 | NS075G3 | NS080G3 | NS085G3 | NS090G3 | NS095G3 | NS100G3 | NS110G3 | NS120G3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Physical Dimensions | Outer Diameter (mm) | | 600 | 650 | 700 | 750 | 800 | 850 | 900 | 950 | 1000 | 1100 | 1200 |
| | Inner Diameter (mm) | | 15 | 15 | 15 | 15 | 20 | 20 | 20 | 20 | 25 | 25 | 25 |
| | Effective Plane Area ($\times 10^2$mm$^2$) | | 2826 | 3317 | 3847 | 4416 | 5023 | 5671 | 6359 | 7085 | 7849 | 9498 | 11305 |
| | Thickness of One Rubber Layer (mm) | | 4.0 | 4.4 | 4.7 | 5.0 | 5.4 | 5.7 | 6.0 | 6.4 | 6.7 | 7.4 | 8.0 |
| | Number of Rubber Layers (–) | | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| | Total Rubber Thickness (mm) | | 120 | 132 | 141 | 150 | 162 | 171 | 180 | 192 | 201 | 222 | 240 |
| | First Shape Factor (–) | | 36.6 | 36.1 | 36.4 | 36.8 | 36.1 | 36.4 | 36.7 | 36.3 | 36.4 | 36.3 | 36.7 |
| | Second Shape Factor (–) | | 5.00 | 4.92 | 4.96 | 5.00 | 4.94 | 4.97 | 5.00 | 4.95 | 4.98 | 4.95 | 5.00 |
| | Diameter of Flange (mm) | | 900 | 950 | 1000 | 1100 | 1150 | 1200 | 1250 | 1300 | 1400 | 1500 | 1600 |
| | Thickness of Flange (mm) | | 22/28 | 22/28 | 22/28 | 22/28 | 24/32 | 24/32 | 28/36 | 28/36 | 28/36 | 30/38 | 32/40 |
| | Diameter of Bolt Center (mm) | | 775 | 825 | 875 | 950 | 1000 | 1050 | 1100 | 1150 | 1250 | 1350 | 1450 |
| | Diameter (Number) of Fixing bolts (mm) | | $\phi$ 33 × 12 | $\phi$ 33 × 12 | $\phi$ 33 × 12 | $\phi$ 33 × 12 | $\phi$ 33 × 12 | $\phi$ 33 × 12 | $\phi$ 33 × 12 | $\phi$ 33 × 12 | $\phi$ 39 × 12 | $\phi$ 39 × 12 | $\phi$ 39 × 12 |
| | Supposed Bolt (–) | | M30 | M30 | M30 | M30 | M30 | M30 | M30 | M30 | M36 | M36 | M36 |
| | Thickness of One Reinforcing Steel Plate (mm) | | 3.1 | 3.1 | 3.1 | 3.1 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 |
| | Height (mm) | | 265.9 | 277.9 | 286.9 | 295.9 | 353.6 | 362.6 | 379.6 | 391.6 | 400.6 | 425.6 | 447.6 |
| | Total Weight (KN) | | 4.8 | 5.6 | 6.4 | 7.5 | 10.5 | 11.7 | 13.8 | 15.3 | 17.3 | 21.3 | 25.8 |
| Compression Properties | Critical Stress (N/mm$^2$) | $\gamma$=0 $\sigma_{cr}$ | 59 | 57 | 58 | 59 | 58 | 58 | 59 | 58 | 58 | 58 | 59 |
| | Ultimate Compressive Stress (N/mm$^2$) | ($\gamma_0$, $\sigma_0$) | (0,40) | (0,40) | (0,40) | (0,40) | (0,40) | (0,40) | (0,40) | (0,40) | (0,40) | (0,40) | (0,40) |
| | | ($\gamma_1$, $\sigma_1$) | (2.1,40) | (1.9,40) | (2.0,40) | (2.1,40) | (2.0,40) | (2.0,40) | (2.1,40) | (2.0,40) | (2.1,40) | (2.0,40) | (2.1,40) |
| | | ($\gamma_2$, $\sigma_2$) | (4.0,23) | (4.0,22) | (4.0,22) | (4.0,23) | (4.0,22) | (4.0,23) | (4.0,23) | (4.0,22) | (4.0,23) | (4.0,22) | (4.0,23) |
| | Compressive Stiffness ($\times 10^3$kN/m) | | 2220 | 2350 | 2560 | 2780 | 2900 | 3120 | 3330 | 3460 | 3670 | 4020 | 4440 |
| | Nominal Long Term Compressive Stress (N/mm$^2$) | | $10.0^{+2.0}_{-2.0}$ | $10.0^{+2.0}_{-2.0}$ | $10.0^{+2.0}_{-2.0}$ | $10.0^{+2.0}_{-2.0}$ | $10.0^{+2.0}_{-2.0}$ | $10.0^{+2.0}_{-2.0}$ | $10.0^{+2.0}_{-2.0}$ | $10.0^{+2.0}_{-2.0}$ | $10.0^{+2.0}_{-2.0}$ | $10.0^{+2.0}_{-2.0}$ | $10.0^{+2.0}_{-2.0}$ |
| | Nominal Long Term Column Load (kN) | | 2830 | 3320 | 3850 | 4420 | 5020 | 5670 | 6360 | 7090 | 7850 | 9500 | 11300 |
| | Allowable Tensile Stress ($\gamma$ =100%) (N/mm$^2$) | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Shear Properties | Shear Stiffness ($\times 10^3$kN/m) (critical stress : $\gamma$ = ± 100%) | | 0.808 | 0.862 | 0.936 | 1.01 | 1.06 | 1.14 | 1.21 | 1.27 | 1.34 | 1.47 | 1.62 |

## ● NS-Series ($S_2$ = 5type)

**Code**

| Designation | Compound | Shear Modulus (N/mm²) |
|---|---|---|
| G5 | G0.45 | 0.441 |

| Characteristics | | | NS060G5 | NS065G5 | NS070G5 | NS075G5 | NS080G5 | NS085G5 | NS090G5 | NS095G5 | NS100G5 | NS110G5 | NS120G5 | NS130G5 | NS140G5 | NU150G5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Physical Dimensions | Outer Diameter (mm) | | 600 | 650 | 700 | 750 | 800 | 850 | 900 | 950 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 |
| | Inner Diameter (mm) | | 15 | 15 | 15 | 15 | 20 | 20 | 20 | 20 | 25 | 25 | 25 | 30 | 30 | 40 |
| | Effective Plane Area ($\times 10^2$mm²) | | 2826 | 3317 | 3847 | 4416 | 5023 | 5671 | 6359 | 7085 | 7849 | 9498 | 11305 | 13266 | 15387 | 17659 |
| | Thickness of One Rubber Layer (mm) | | 4.0 | 4.4 | 4.7 | 5.0 | 5.4 | 5.7 | 6.0 | 6.4 | 6.7 | 7.4 | 8.0 | 8.7 | 9.3 | 8.5 |
| | Number of Rubber Layers (–) | | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 35 |
| | Total Rubber Thickness (mm) | | 120 | 132 | 141 | 150 | 162 | 171 | 180 | 192 | 201 | 222 | 240 | 261 | 279 | 298 |
| | First Shape Factor (–) | | 36.6 | 36.1 | 36.4 | 36.8 | 36.1 | 36.4 | 36.7 | 36.3 | 36.4 | 36.3 | 36.7 | 36.5 | 36.8 | 42.9 |
| | Second Shape Factor (–) | | 5.00 | 4.92 | 4.96 | 5.00 | 4.94 | 4.97 | 5.00 | 4.95 | 4.98 | 4.95 | 5.00 | 4.98 | 5.02 | 5.04 |
| | Diameter of Flange (mm) | | 900 | 950 | 1000 | 1100 | 1150 | 1200 | 1250 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 |
| | Thickness of Flange (mm) | | 22/28 | 22/28 | 22/28 | 22/28 | 24/32 | 24/32 | 28/36 | 28/36 | 28/36 | 30/38 | 32/40 | 32/40 | 37/45 | 50/100 |
| | Diameter of Bolt Center (mm) | | 775 | 825 | 875 | 950 | 1000 | 1050 | 1100 | 1150 | 1250 | 1350 | 1450 | 1550 | 1650 | 1700 |
| | Diameter (Number) of Fixing bolts (mm) | | φ33×12 | φ33×12 | φ33×12 | φ33×12 | φ33×12 | φ33×12 | φ33×12 | φ33×12 | φ39×12 | φ39×12 | φ39×12 | φ39×12 | φ42×12 | φ42×12 |
| | Supposed Bolt (–) | | M30 | M30 | M30 | M30 | M30 | M30 | M30 | M30 | M36 | M36 | M36 | M36 | M39 | M39 |
| | Thickness of One Reinforcing Steel Plate (mm) | | 3.1 | 3.1 | 3.1 | 3.1 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 5.8 | 5.8 |
| | Height (mm) | | 265.9 | 277.9 | 286.9 | 295.9 | 353.6 | 362.6 | 379.6 | 391.6 | 400.6 | 425.6 | 447.6 | 468.6 | 537.2 | 694.7 |
| | Total Weight (KN) | | 4.8 | 5.6 | 6.4 | 7.5 | 10.5 | 11.7 | 13.8 | 15.3 | 17.3 | 21.3 | 25.8 | 30.1 | 41.6 | 69.2 |
| Compression Properties | Critical Stress (N/mm²) | $\gamma$=0 $\sigma_{cr}$ | 72 | 70 | 71 | 72 | 71 | 71 | 72 | 71 | 72 | 71 | 72 | 72 | 73 | 77 |
| | Ultimate Compressive Stress (N/mm²) | ($\gamma_0$, $\sigma_0$) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) |
| | | ($\gamma_1$, $\sigma_1$) | (1.1,60) | (0.9,60) | (1.0,60) | (1.1,60) | (1.0,60) | (1.0,60) | (1.1,60) | (1.0,60) | (1.1,60) | (1.0,60) | (1.1,60) | (1.1,60) | (1.2,60) | (1.5,60) |
| | | ($\gamma_2$, $\sigma_2$) | (4.0,28) | (4.0,26) | (4.0,27) | (4.0,28) | (4.0,27) | (4.0,28) | (4.0,28) | (4.0,27) | (4.0,28) | (4.0,27) | (4.0,28) | (4.0,28) | (4.0,29) | (4.0,31) |
| | Compressive Stiffness ($\times 10^3$kN/m) | | 2490 | 2640 | 2880 | 3110 | 3260 | 3500 | 3730 | 3890 | 4110 | 4510 | 4980 | 5360 | 5840 | 6610 |
| | Nominal Long Term Compressive Stress (N/mm²) | | $15.0^{+0.0}_{-3.0}$ | $15.0^{+0.0}_{-3.0}$ | $15.0^{+0.0}_{-3.0}$ | $15.0^{+0.0}_{-3.0}$ | $15.0^{+0.0}_{-3.0}$ | $15.0^{+0.0}_{-3.0}$ | $15.0^{+0.0}_{-3.0}$ | $15.0^{+0.0}_{-3.0}$ | $15.0^{+0.0}_{-3.0}$ | $15.0^{+0.0}_{-3.0}$ | $15.0^{+0.0}_{-3.0}$ | $15.0^{+0.0}_{-3.0}$ | $15.0^{+0.0}_{-3.0}$ | $15.0^{+0.0}_{-3.0}$ |
| | Nominal Long Term Column Load (kN) | | 4240 | 4970 | 5770 | 6620 | 7540 | 8510 | 9540 | 10600 | 11800 | 14200 | 17000 | 19900 | 23100 | 26500 |
| | Allowable Tensile Stress ($\gamma$ =100%) (N/mm²) | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Shear Properties | Shear Stiffness ($\times 10^3$kN/m) (critical stress : $\gamma$ = ± 100%) | | 1.04 | 1.11 | 1.20 | 1.30 | 1.37 | 1.46 | 1.56 | 1.63 | 1.72 | 1.89 | 2.08 | 2.24 | 2.43 | 2.62 |

## ● NS-Series ($S_2$ = 5type)

**Code**

| Designation | Compound | Shear Modulus ($N/mm^2$) |
|---|---|---|
| G4 | G0.40 | 0.392 |

| Characteristics | | | NS060G4 | NS065G4 | NS070G4 | NS075G4 | NS080G4 | NS085G4 | NS090G4 | NS095G4 | NS100G4 | NS110G4 | NS120G4 | NS130G4 | NS140G4 | NU150G4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Physical Dimensions | Outer Diameter (mm) | | 600 | 650 | 700 | 750 | 800 | 850 | 900 | 950 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 |
| | Inner Diameter (mm) | | 15 | 15 | 15 | 15 | 20 | 20 | 20 | 20 | 25 | 25 | 25 | 30 | 30 | 40 |
| | Effective Plane Area ($\times 10^2 mm^2$) | | 2826 | 3317 | 3847 | 4416 | 5023 | 5671 | 6359 | 7085 | 7849 | 9498 | 11305 | 13266 | 15387 | 17659 |
| | Thickness of One Rubber Layer (mm) | | 4.0 | 4.4 | 4.7 | 5.0 | 5.4 | 5.7 | 6.0 | 6.4 | 6.7 | 7.4 | 8.0 | 8.7 | 9.3 | 8.5 |
| | Number of Rubber Layers (–) | | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 35 |
| | Total Rubber Thickness (mm) | | 120 | 132 | 141 | 150 | 162 | 171 | 180 | 192 | 201 | 222 | 240 | 261 | 279 | 298 |
| | First Shape Factor (–) | | 36.6 | 36.1 | 36.4 | 36.8 | 36.1 | 36.4 | 36.7 | 36.3 | 36.4 | 36.3 | 36.7 | 36.5 | 36.8 | 42.9 |
| | Second Shape Factor (–) | | 5.00 | 4.92 | 4.96 | 5.00 | 4.94 | 4.97 | 5.00 | 4.95 | 4.98 | 4.95 | 5.00 | 4.98 | 5.02 | 5.04 |
| | Diameter of Flange (mm) | | 900 | 950 | 1000 | 1100 | 1150 | 1200 | 1250 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 |
| | Thickness of Flange (mm) | | 22/28 | 22/28 | 22/28 | 22/28 | 24/32 | 24/32 | 28/36 | 28/36 | 28/36 | 30/38 | 32/40 | 32/40 | 37/45 | 50/100 |
| | Diameter of Bolt Center (mm) | | 775 | 825 | 875 | 950 | 1000 | 1050 | 1100 | 1150 | 1250 | 1350 | 1450 | 1550 | 1650 | 1700 |
| | Diameter (Number) of Fixing bolts (mm) | | φ33×12 | φ33×12 | φ33×12 | φ33×12 | φ33×12 | φ33×12 | φ33×12 | φ33×12 | φ39×12 | φ39×12 | φ39×12 | φ39×12 | φ42×12 | φ42×12 |
| | Supposed Bolt (–) | | M30 | M30 | M30 | M30 | M30 | M30 | M30 | M30 | M36 | M36 | M36 | M36 | M39 | M39 |
| | Thickness of One Reinforcing Steel Plate (mm) | | 3.1 | 3.1 | 3.1 | 3.1 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 5.8 | 5.8 |
| | Height (mm) | | 265.9 | 277.9 | 286.9 | 295.9 | 353.6 | 362.6 | 379.6 | 391.6 | 400.6 | 425.6 | 447.6 | 468.6 | 537.2 | 694.7 |
| | Total Weight (KN) | | 4.8 | 5.6 | 6.4 | 7.5 | 10.5 | 11.7 | 13.8 | 15.3 | 17.3 | 21.3 | 25.8 | 30.1 | 41.6 | 69.2 |
| Compression Properties | Critical Stress ($N/mm^2$) | $\gamma=0$ $\sigma_{cr}$ | 65 | 63 | 64 | 65 | 63 | 64 | 65 | 64 | 64 | 64 | 65 | 65 | 65 | 70 |
| | Ultimate Compressive Stress ($N/mm^2$) | ($\gamma_0, \sigma_0$) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) |
| | | ($\gamma_1, \sigma_1$) | (0.5,60) | (0.3,60) | (0.4,60) | (0.5,60) | (0.3,60) | (0.4,60) | (0.5,60) | (0.4,60) | (0.4,60) | (0.4,60) | (0.5,60) | (0.5,60) | (0.5,60) | (0.9,60) |
| | | ($\gamma_2, \sigma_2$) | (4.0,25) | (4.0,24) | (4.0,25) | (4.0,26) | (4.0,24) | (4.0,25) | (4.0,25) | (4.0,24) | (4.0,25) | (4.0,24) | (4.0,26) | (4.0,25) | (4.0,26) | (4.0,28) |
| | Compressive Stiffness ($\times 10^3 kN/m$) | | 2280 | 2420 | 2640 | 2850 | 2990 | 3200 | 3420 | 3560 | 3770 | 4130 | 4570 | 4920 | 5350 | 6070 |
| | Nominal Long Term Compressive Stress ($N/mm^2$) | | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ |
| | Nominal Long Term Column Load (kN) | | 4240 | 4970 | 5770 | 6620 | 7540 | 8510 | 9540 | 10600 | 11800 | 14200 | 17000 | 19900 | 23100 | 26500 |
| | Allowable Tensile Stress ($\gamma$ =100%) ($N/mm^2$) | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Shear Properties | Shear Stiffness ($\times 10^3 kN/m$) (critical stress : $\gamma = \pm 100\%$) | | 0.923 | 0.985 | 1.07 | 1.15 | 1.22 | 1.30 | 1.38 | 1.45 | 1.53 | 1.68 | 1.85 | 1.99 | 2.16 | 2.33 |

## NH-Series (Total Rabber Thickness 200mm)

**Code**

| Designation | Compound | Shear Modulus ($N/mm^2$) |
|---|---|---|
| G4 | G0.40 | 0.392 |

| Characteristics | | | NH060G4 | NH065G4 | NH070G4 | NH075G4 | NH080G4 | NH085G4 | NH090G4 | NH095G4 | NH100G4 | NH110G4 | NH120G4 | NH130G4 | NH140G4 | NH150G4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Physical Dimensions | Outer Diameter (mm) | | 600 | 650 | 700 | 750 | 800 | 850 | 900 | 950 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 |
| | Inner Diameter (mm) | | 15 | 15 | 15 | 15 | 20 | 20 | 20 | 20 | 25 | 25 | 25 | 30 | 30 | 40 |
| | Effective Plane Area ($\times 10^2 mm^2$) | | 2826 | 3317 | 3847 | 4416 | 5023 | 5671 | 6359 | 7085 | 7849 | 9498 | 11305 | 13266 | 15387 | 17659 |
| | Thickness of One Rubber Layer (mm) | | 4.0 | 4.4 | 4.7 | 5.0 | 5.4 | 5.7 | 6.0 | 6.4 | 6.7 | 7.4 | 8.0 | 8.7 | 9.5 | 10 |
| | Number of Rubber Layers (—) | | 50 | 45 | 43 | 40 | 37 | 35 | 33 | 31 | 30 | 27 | 25 | 23 | 21 | 20 |
| | Total Rubber Thickness (mm) | | 200 | 198 | 202 | 200 | 200 | 200 | 198 | 198 | 201 | 200 | 200 | 200 | 200 | 200 |
| | First Shape Factor (—) | | 36.6 | 36.1 | 36.4 | 36.8 | 36.1 | 36.4 | 36.7 | 36.3 | 36.4 | 36.3 | 36.7 | 36.5 | 36.1 | 36.5 |
| | Second Shape Factor (—) | | 3.00 | 3.28 | 3.46 | 3.75 | 4.00 | 4.26 | 4.55 | 4.79 | 4.98 | 5.51 | 6.00 | 6.50 | 7.02 | 7.50 |
| | Diameter of Flange (mm) | | 900 | 950 | 1000 | 1100 | 1150 | 1200 | 1250 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 |
| | Thickness of Flange (mm) | | 22/28 | 22/28 | 22/28 | 22/28 | 24/32 | 24/32 | 28/36 | 28/36 | 28/36 | 30/38 | 32/40 | 32/40 | 37/45 | 42/50 |
| | Diameter of Bolt Center (mm) | | 775 | 825 | 875 | 950 | 1000 | 1050 | 1100 | 1150 | 1250 | 1350 | 1450 | 1550 | 1650 | 1750 |
| | Diameter (Number) of Fixing bolts (mm) | | $\phi$33×12 | $\phi$33×12 | $\phi$33×12 | $\phi$33×12 | $\phi$33×12 | $\phi$33×12 | $\phi$33×12 | $\phi$33×12 | $\phi$39×12 | $\phi$39×12 | $\phi$39×12 | $\phi$39×12 | $\phi$42×12 | $\phi$42×16 |
| | Supposed Bolt (—) | | M30 | M30 | M30 | M30 | M30 | M30 | M30 | M30 | M36 | M36 | M36 | M36 | M39 | M39 |
| | Thickness of One Reinforcing Steel Plate (mm) | | 3.1 | 3.1 | 3.1 | 3.1 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 5.8 | 5.8 |
| | Height (mm) | | 407.9 | 390.4 | 388.3 | 376.9 | 422.2 | 413.1 | 410.8 | 402.4 | 400.6 | 390.2 | 385.6 | 376.9 | 405.5 | 410.2 |
| | Total Weight (KN) | | 6.5 | 7.0 | 7.9 | 8.9 | 11.9 | 12.9 | 14.6 | 15.6 | 17.3 | 20.1 | 23.3 | 26.0 | 34.0 | 39.9 |
| Compression Properties | Critical Stress ($N/mm^2$) | $\gamma$=0 $\sigma_{cr}$ | 31 | 35 | 38 | 43 | 47 | 51 | 56 | 61 | 64 | 71 | 78 | 84 | 91 | 97 |
| | Ultimate Compressive Stress ($N/mm^2$) | ($\gamma_0, \sigma_0$) | (0,31) | (0,35) | (0,38) | (0,43) | (0,47) | (0,51) | (0,56) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) |
| | | ($\gamma_1, \sigma_1$) | – | – | – | – | – | – | – | (0.1,60) | (0.4,60) | (1.2,60) | (1.8,60) | (2.5,60) | (3.1,60) | (3.8,60) |
| | | ($\gamma_2, \sigma_2$) | (2.8,0) | (3.2,0) | (3.5,0) | (3.8,3) | (4.0,5) | (4.0,10) | (4.0,16) | (4.0,21) | (4.0,25) | (4.0,32) | (4.0,39) | (4.0,45) | (4.0,51) | (4.0,58) |
| | Compressive Stiffness ($\times 10^3 kN/m$) | | 1370 | 1610 | 1840 | 2140 | 2420 | 2750 | 3110 | 3450 | 3770 | 4590 | 5480 | 6410 | 7420 | 8540 |
| | Nominal Long Term Compressive Stress ($N/mm^2$) | | $6.0^{+0.9}_{-1.4}$ | $7.0^{+1.1}_{-1.6}$ | $7.8^{+1.1}_{-1.8}$ | $8.9^{+1.4}_{-1.8}$ | $9.8^{+1.5}_{-2.0}$ | $10.8^{+1.7}_{-2.3}$ | $12.0^{+1.9}_{-2.8}$ | $13.0^{+2.0}_{-3.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ |
| | Nominal Long Term Column Load (kN) | | 1700 | 2320 | 3000 | 3930 | 4920 | 6130 | 7630 | 9200 | 11800 | 14200 | 17000 | 19900 | 23100 | 26500 |
| | Allowable Tensile Stress ($\gamma$ =100%) ($N/mm^2$) | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Shear Properties | Shear Stiffness ($\times 10^3 kN/m$) (critical stress : $\gamma = \pm 100\%$) | | 0.554 | 0.657 | 0.747 | 0.866 | 0.986 | 1.11 | 1.26 | 1.40 | 1.53 | 1.86 | 2.22 | 2.60 | 3.02 | 3.46 |

## NL-Series (Total Rabber Thickness 160mm)

**Code**

| Designation | Compound | Shear Modulus ($N/mm^2$) |
|---|---|---|
| G4 | G0.40 | 0.392 |

| Characteristics | | | NL060G4 | NL065G4 | NL070G4 | NL075G4 | NL080G4 | NL085G4 | NL090G4 | NL095G4 | NL100G4 | NL110G4 | NL120G4 | NL130G4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Physical Dimensions | Outer Diameter (mm) | | 600 | 650 | 700 | 750 | 800 | 850 | 900 | 950 | 1000 | 1100 | 1200 | 1300 |
| | Inner Diameter (mm) | | 15 | 15 | 15 | 15 | 20 | 20 | 20 | 20 | 25 | 25 | 25 | 30 |
| | Effective Plane Area ($\times 10^2 mm^2$) | | 2826 | 3317 | 3847 | 4416 | 5023 | 5671 | 6359 | 7085 | 7849 | 9498 | 11305 | 13266 |
| | Thickness of One Rubber Layer (mm) | | 4.0 | 4.4 | 4.9 | 4.9 | 5.1 | 5.3 | 5.7 | 6.0 | 6.4 | 7.2 | 7.7 | 8.0 |
| | Number of Rubber Layers (–) | | 41 | 37 | 34 | 34 | 33 | 32 | 30 | 28 | 26 | 23 | 22 | 21 |
| | Total Rubber Thickness (mm) | | 162 | 163 | 167 | 165 | 168 | 168 | 170 | 168 | 165 | 166 | 169 | 168 |
| | First Shape Factor (–) | | 37.0 | 36.1 | 34.9 | 37.9 | 38.2 | 39.5 | 38.9 | 38.8 | 38.4 | 37.3 | 38.1 | 39.7 |
| | Second Shape Factor (–) | | 3.70 | 3.99 | 4.20 | 4.55 | 4.75 | 5.06 | 5.31 | 5.65 | 6.06 | 6.64 | 7.08 | 7.74 |
| | Diameter of Flange (mm) | | 900 | 950 | 1000 | 1100 | 1150 | 1200 | 1250 | 1300 | 1400 | 1500 | 1600 | 1700 |
| | Thickness of Flange (mm) | | 22/28 | 22/28 | 22/28 | 22/28 | 24/32 | 24/32 | 28/36 | 28/36 | 28/36 | 30/38 | 32/40 | 32/40 |
| | Diameter of Bolt Center (mm) | | 775 | 825 | 875 | 950 | 1000 | 1050 | 1100 | 1150 | 1250 | 1350 | 1450 | 1550 |
| | Diameter (Number) of Fixing bolts (mm) | | $\phi$ 33 × 12 | $\phi$ 33 × 12 | $\phi$ 33 × 12 | $\phi$ 33 × 12 | $\phi$ 33 × 12 | $\phi$ 33 × 12 | $\phi$ 33 × 12 | $\phi$ 33 × 12 | $\phi$ 39 × 12 | $\phi$ 39 × 12 | $\phi$ 39 × 12 | $\phi$ 39 × 12 |
| | Supposed Bolt (–) | | M30 | M30 | M30 | M30 | M30 | M30 | M30 | M30 | M36 | M36 | M36 | M36 |
| | Thickness of One Reinforcing Steel Plate (mm) | | 3.1 | 3.1 | 3.1 | 3.1 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 5.8 |
| | Height (mm) | | 342.0 | 330.4 | 324.9 | 323.2 | 373.1 | 368.4 | 369.1 | 358.8 | 347.1 | 338.4 | 341.8 | 364.0 |
| | Total Weight (KN) | | 5.7 | 6.3 | 6.9 | 8.1 | 11.0 | 12.1 | 13.7 | 14.5 | 15.9 | 18.4 | 21.8 | 27.5 |
| Compression Properties | Critical Stress ($N/mm^2$) | $\gamma=0$ $\sigma_{cr}$ | 42 | 46 | 49 | 57 | 61 | 68 | 71 | 75 | 80 | 87 | 94 | 104 |
| | Ultimate Compressive Stress ($N/mm^2$) | ($\gamma_0, \sigma_0$) | (0,42) | (0,46) | (0,49) | (0,57) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) |
| | | ($\gamma_1, \sigma_1$) | – | – | – | – | (0.1,60) | (0.8,60) | (1.1,60) | (1.5,60) | (2.0,60) | (2.7,60) | (3.3,60) | (4.0,60) |
| | | ($\gamma_2, \sigma_2$) | (3.7,2) | (4.0,5) | (4.0,9) | (4.0,16) | (4.0,21) | (4.0,27) | (4.0,30) | (4.0,35) | (4.0,40) | (4.0,47) | (4.0,53) | (4.0,60) |
| | Compressive Stiffness ($\times 10^3 kN/m$) | | 1700 | 1960 | 2190 | 2630 | 2940 | 3360 | 3720 | 4170 | 4690 | 5590 | 6560 | 7870 |
| | Nominal Long Term Compressive Stress ($N/mm^2$) | | $8.7^{+1.4}_{-1.8}$ | $9.7^{+1.5}_{-2.0}$ | $10.5^{+1.7}_{-2.3}$ | $12.1^{+1.9}_{-2.8}$ | $13.0^{+2.0}_{-3.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ | $15.0^{+0.0}_{-5.0}$ |
| | Nominal Long Term Column Load (kN) | | 2460 | 3220 | 4040 | 5340 | 6530 | 8510 | 9540 | 10630 | 11800 | 14200 | 17000 | 19900 |
| | Allowable Tensile Stress ($\gamma$ =100%) ($N/mm^2$) | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Shear Properties | Shear Stiffness ($\times 10^3 kN/m$) (critical stress : $\gamma = \pm 100\%$) | | 0.684 | 0.799 | 0.905 | 1.05 | 1.17 | 1.32 | 1.47 | 1.65 | 1.86 | 2.25 | 2.62 | 3.10 |

## NT-Series (Total Rabber Thickness 250mm)

**Code**

| Designation | Compound | Shear Modulus ($N/mm^2$) |
|---|---|---|
| G4 | G0.40 | 0.392 |

| Characteristics | | | NT090G4 | NT100G4 | NT110G4 | NT120G4 | NT130G4 | NT140G4 | NT150G4 | NT160G4 |
|---|---|---|---|---|---|---|---|---|---|---|
| Physical Dimensions | Outer Diameter (mm) | | 900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 |
| | Inner Diameter (mm) | | 20 | 25 | 25 | 25 | 30 | 30 | 40 | 80 |
| | Effective Plane Area ($\times 10^2 mm^2$) | | 6359 | 7849 | 9498 | 11305 | 13266 | 15387 | 17659 | 20056 |
| | Thickness of One Rubber Layer (mm) | | 6.0 | 6.7 | 7.4 | 8.0 | 8.7 | 9.5 | 10 | 10.4 |
| | Number of Rubber Layers (–) | | 42 | 37 | 34 | 31 | 29 | 26 | 25 | 24 |
| | Total Rubber Thickness (mm) | | 252 | 248 | 252 | 248 | 252 | 247 | 250 | 250 |
| | First Shape Factor (–) | | 36.7 | 36.4 | 36.3 | 36.7 | 36.5 | 36.1 | 36.5 | 36.5 |
| | Second Shape Factor (–) | | 3.57 | 4.03 | 4.37 | 4.84 | 5.15 | 5.67 | 6.00 | 6.41 |
| | Diameter of Flange (mm) | | 1250 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 |
| | Thickness of Flange (mm) | | 28/36 | 28/36 | 30/38 | 32/40 | 32/40 | 37/45 | 42/50 | 50/110 |
| | Diameter of Bolt Center (mm) | | 1100 | 1250 | 1350 | 1450 | 1550 | 1650 | 1750 | 1800 |
| | Diameter (Number) of Fixing bolts (mm) | | $\phi$ 33 × 12 | $\phi$ 39 × 12 | $\phi$ 39 × 12 | $\phi$ 39 × 12 | $\phi$ 39 × 12 | $\phi$ 42 × 12 | $\phi$ 42 × 16 | $\phi$ 45 × 12 |
| | Supposed Bolt (–) | | M30 | M36 | M36 | M36 | M36 | M39 | M39 | M42 |
| | Thickness of One Reinforcing Steel Plate (mm) | | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 5.8 | 5.8 | 5.8 |
| | Height (mm) | | 504.4 | 478.3 | 472.8 | 460.0 | 455.5 | 482.0 | 489.2 | 603.0 |
| | Total Weight (KN) | | 16.9 | 19.6 | 22.9 | 26.3 | 29.5 | 38.3 | 44.8 | 70.7 |
| Compression Properties | Critical Stress ($N/mm^2$) | $\gamma$=0 $\sigma_{cr}$ | 40 | 47 | 53 | 62 | 67 | 73 | 78 | 83 |
| | Ultimate Compressive Stress ($N/mm^2$) | ($\gamma_0, \sigma_0$) | (0,40) | (0,47) | (0,53) | (0,60) | (0,60) | (0,60) | (0,60) | (0,60) |
| | | ($\gamma_1, \sigma_1$) | – | – | – | (0.2,60) | (0.7,60) | (1.3,60) | (1.8,60) | (2.4,60) |
| | | ($\gamma_2, \sigma_2$) | (3.6,1) | (4.0,6) | (4.0,12) | (4.0,22) | (4.0,27) | (4.0,34) | (4.0,38) | (4.0,44) |
| | Compressive Stiffness ($\times 10^3 kN/m$) | | 2440 | 3060 | 3640 | 4420 | 5090 | 6000 | 6830 | 7770 |
| | Nominal Long Term Compressive Stress ($N/mm^2$) | | 8.2 $^{+1.3}_{-1.9}$ | 9.9 $^{+1.5}_{-2.3}$ | 11.3 $^{+1.7}_{-2.6}$ | 13.2 $^{+1.8}_{-3.0}$ | 15.0 $^{+0.0}_{-5.0}$ | 15.0 $^{+0.0}_{-5.0}$ | 15.0 $^{+0.0}_{-5.0}$ | 15.0 $^{+0.0}_{-5.0}$ |
| | Nominal Long Term Column Load (kN) | | 5210 | 7770 | 10700 | 14900 | 19900 | 23100 | 26500 | 30100 |
| | Allowable Tensile Stress ($\gamma$ =100%) ($N/mm^2$) | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Shear Properties | Shear Stiffness ($\times 10^3 kN/m$) (critical stress : $\gamma = \pm 100\%$) | | 0.989 | 1.24 | 1.48 | 1.79 | 2.06 | 2.44 | 2.77 | 3.15 |

# Dimension and Performance Properties of Elastic Sliding Bearing

## ● SL-Series ($\mu$= 0.13,G1.2 タイプ)

**Code**

| Designation | Compound | Shear Modulus (N/mm$^2$) |
|---|---|---|
| GC | G1.2 | 1.18 |

| Characteristics | | SL030GC | SL040GC | SL050GC | SL060GC | SL070GC | SL080GC |
|---|---|---|---|---|---|---|---|
| Dimensions | Outer diameter (exclude cover rubber) (mm) | 300 | 400 | 500 | 600 | 700 | 800 |
| | Inner diameter of reinforcing steel plate (mm) | 0 | 0 | 0 | 0 | 0 | 0 |
| | Effective outer diameter (mm) | 300 | 400 | 500 | 600 | 700 | 800 |
| | Effective Plane Area ($\times 10^2$mm$^2$) | 707 | 1257 | 1963 | 2827 | 3848 | 5027 |
| | Thickness of one rubber layer (mm) | 3.5 | 5.0 | 6.0 | 7.5 | 8.7 | 10.0 |
| | Number of rubber layers (–) | 12 | 12 | 10 | 8 | 7 | 6 |
| | Total rubber thickness (mm) | 42 | 60 | 60 | 60 | 61 | 60 |
| | First shape factor (–) | 21.4 | 20.0 | 20.8 | 20.0 | 20.1 | 20.0 |
| | Second shape factor (–) | 7.14 | 6.67 | 8.33 | 10.0 | 11.5 | 13.3 |
| | Diameter of sliding material (PTFE) (mm) | 308 | 408 | 508 | 608 | 708 | 808 |
| | Diameter of flange (mm) | 500 | 650 | 750 | 900 | 1000 | 1150 |
| | Thickness of flange (mm) | 16/22 | 16/22 | 22/28 | 22/28 | 22/28 | 24/32 |
| | Diameter of bolt center (mm) | 420 | 550 | 650 | 775 | 875 | 1000 |
| | Number of fixing bolts and Diameter of bolt hole (mm) | $\phi$ 27 × 8 | $\phi$ 27 × 8 | $\phi$ 27 × 8 | $\phi$ 33 × 8 | $\phi$ 33 × 8 | $\phi$ 33 × 8 |
| | Size of bolts (–) | M24 | M24 | M24 | M30 | M30 | M30 |
| | Thickness of one reinforcing steel plate (mm) | 2.2 | 2.2 | 2.2 | 3.1 | 3.1 | 3.1 |
| | Height (bearing) (mm) | 103.2 | 121.2 | 122.8 | 132.7 | 130.5 | 130.5 |
| | Weight (bearing) (KN) | 0.5 | 0.9 | 1.5 | 2.4 | 3.0 | 4.0 |
| | Ultimate displacement (mm) | (outer diameter of SUS Plate- effective Area) / 2 | | | | | |
| Vertical Properties | Ultimate compressive stress (N/mm$^2$) | 50 | | | | | |
| | Design compressive stress (N/mm$^2$) | 10 | | | | | |
| | Design compressive force (kN) | 707 | 1260 | 1960 | 2830 | 3850 | 5030 |
| | Compressive stiffness ($\times 10^3$kN/m) | 1730 | 2040 | 3290 | 4600 | 6190 | 8170 |
| | Allowable tensile stress (N/mm$^2$) | 0 | | | | | |
| Horizontal Properties | Initial stiffness ($\times 10^3$kN/m) | 1.98 | 2.46 | 3.85 | 5.55 | 7.44 | 9.86 |
| | Post-yield stiffness ($\times 10^3$kN/m) | 0 | | | | | |
| Friction Properties | Dynamic friction coeficient (–) | 0.13 ($\sigma$ =10 (N/mm$^2$) , V (velocity)=100 (mm/s)) | | | | | |

Design Formula SL : $\mu = (0.112 - 0.00276\,\sigma)\ V^{0.0863}$

| Characteristics | | QL13228 | QL14228 | QL15228 | QL16231 | QL17231 | QL18231 | QL19231 | QL20231 | QL21231 | QL22231 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Base (Back) Plate Properties (Stainless Plate) | Outer diameter of base plate (mm) | □1320 | □1420 | □1520 | □1620 | □1720 | □1820 | □1920 | □2020 | □2120 | □2220 |
| | Outer diameter of stainless plate (mm) | □1300 | □1400 | □1500 | □1600 | □1700 | □1800 | □1900 | □2000 | □2100 | □2200 |
| | Inner diameter of stainless plate (mm) | 550 | 600 | 650 | 700 | 750 | 800 | 850 | 900 | 950 | 1000 |
| | Total thickness (mm) | 28 | 28 | 28 | 31 | 31 | 31 | 31 | 31 | 31 | 31 |
| | Connecting bolt hole position $L_{b1}$ (mm) | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 |
| | Connecting bolt hole position $L_{b2}$ (mm) | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 |
| | Number of fixing bolts and Diameter of bolt hole (mm) | $\phi$ 35 × 8 | $\phi$ 35 × 8 | $\phi$ 35 × 8 | $\phi$ 41 × 8 | $\phi$ 41 × 8 | $\phi$ 41 × 8 | $\phi$ 41 × 8 | $\phi$ 41 × 8 | $\phi$ 41 × 8 | $\phi$ 41 × 8 |
| | Size of bolts (–) | M30 | M30 | M30 | M36 | M36 | M36 | M36 | M36 | M36 | M36 |
| | Weight (kN) | 3.7 | 4.3 | 4.9 | 6.1 | 6.8 | 7.7 | 8.5 | 9.4 | 10.4 | 11.4 |

●The information in this catalogue is subject to change without any prior notice.
For more information, please kindly contact our company.

●The information in this catalogue is up to date until June 2013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