



INTERNATIONAL
HIRUN
ENGINEERING SOLUTION



Temburong Bridge - Brunei

HIDAMP – HILEAD

HDRB - LRB ISOLATORS

CE MARKED

G&P
intech
Distributore esclusivo

◎ GENERAL

Founded in 1998, Wuhan Hirun Engineering Equipment Co., Ltd. (HIRUN) is the wholly owned subsidiary of Wuhan Marine Machinery Plant Co., Ltd. (WMMP), which is the subsidiary of China Shipbuilding Industry Corporation (CSIC), one of world's top 500 enterprises, and it is a professional manufacturing enterprise of research, development, production and sales in bridge and anti-seismic products.

◎ STANDARD AND QUALITY ASSURANCE

HIDAMP and HILEAD Isolators are designed, manufactured and tested in accordance with EN 15129. CE marking procedure with supervision of the Notified Body ICECON that executes the regular audit visits as foreseen by the EN standard is now in progress.

In alternative they can be designed, manufactured and tested in accordance with ISO 22762 or AASHTO.

The whole production of HIRUN is subjected to a quality assurance program in accordance with ISO 9000 certified by CQC, member of the International Mutual Acknowledgment Body IQNET.

In addition the production of the Isolators is subjected to a specific quality assurance program in accordance with EN 15129 Annex ZA for the CE marking with the supervision of the Notified Body ICECON.

Hirun is also certified for the execution of steel and aluminum structures with CE certificate according to EN 1090.

The relevant certificates are shown here below.



ISO 9001 certificates



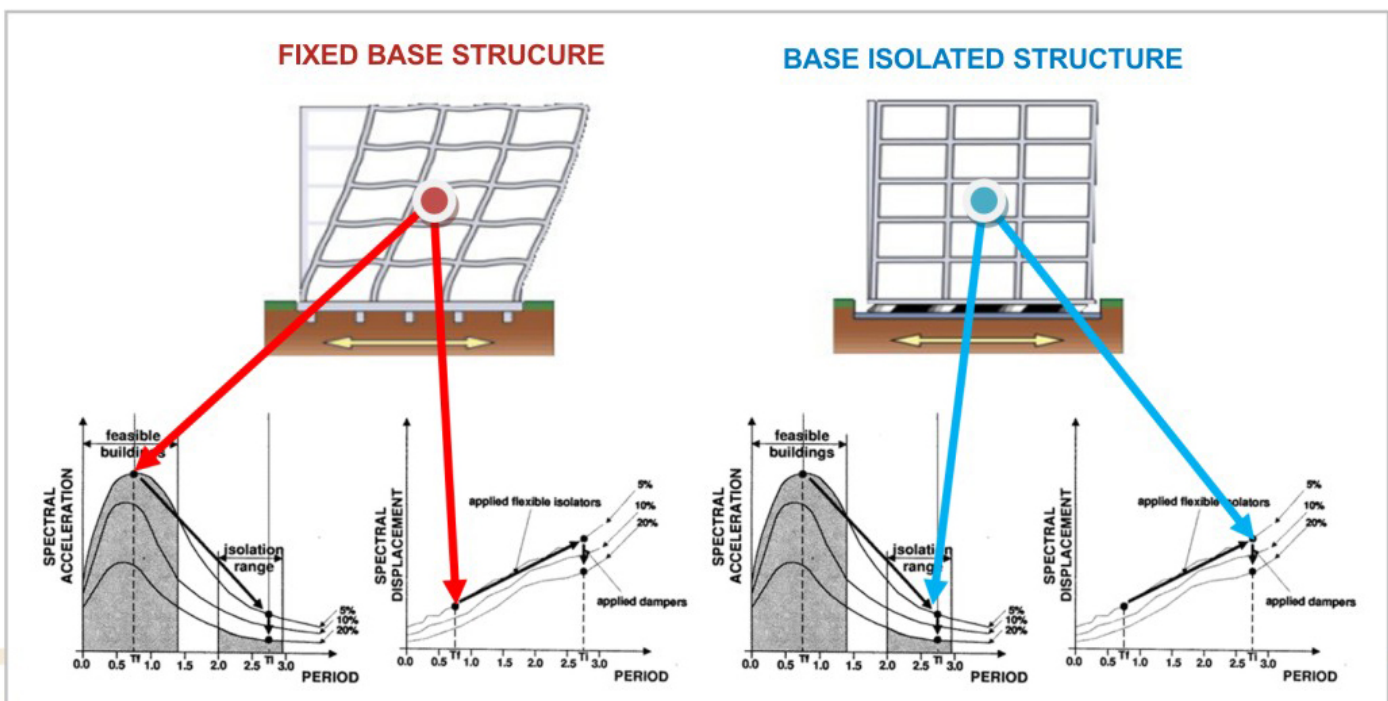
EN 1090 certificate

◎ BASIC PRINCIPLES AND REQUIREMENTS OF THE BASE ISOLATION

The reduction of the seismic response of a structure may be achieved by one of the following strategies or by a combination of them:

- Shifting the natural period of the structures to a field of lesser acceleration response
- Dissipating energy (damping)

It is easy to understand the effects of anti-seismic devices based on the above mentioned strategies examining a typical acceleration response spectrum diagram. This diagram represents the behaviour of a structure under the effect of an earthquake and clearly shows that rigid structures amplify the ground acceleration whilst soft ones reduce it. The diagram also clearly shows the influence of the energy dissipation in reducing the acceleration of the structure.



Quite often there is a price to be paid for any advantage got. In this case the price to be paid is the relative displacement that the anti-seismic devices induce between the parts of the structure. The relative displacements are shown in the following graph in function of the natural period of the structure.

The diagram clearly shows the great advantage given by the energy dissipation in terms of reduction of the displacements. Especially for bridges a high value of the damping has no undesirable effects and therefore shall be adopted in order to reduce all necessary clearances in correspondence of the bearings and the joints.

STANDARD DEFINITIONS AND THEORETICAL FORMULA

Base isolators, as defined in the EN 15129 are the devices or the combination of devices providing the following four functions:

1. Support the weight of the structures.
2. Provide lateral displacement capability.
3. Provide re-centring capability.
4. Dissipate energy.

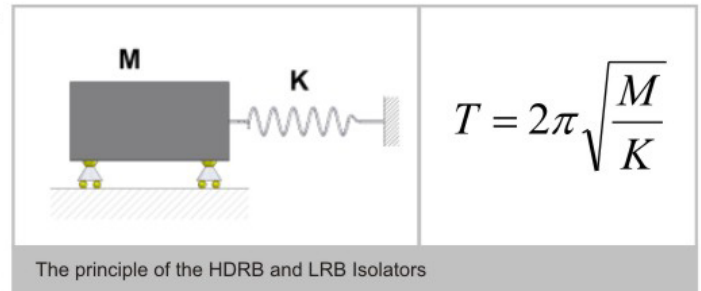
HDRB and LRB indeed are very efficient systems of base isolators. They are based on the principle of the spring-mass system and they force the structure to oscillate in accordance to their own period.

The spring effect is given by the elasticity of the rubber.

The energy dissipation is given:

- In the HDRB by the viscosity of the rubber
- In the LRB by the yield of the lead core

HDRB and LRB can be modelled as linear springs, taking into account the damping by the formula.



$$\eta = \sqrt{\frac{10}{5 + \xi}}$$

Where η is a parameter reducing the response spectrum and ξ is the equivalent viscous damping.

TESTS

All relevant tests can be performed in the HIRUN testing facility having the following performances:

- Vertical load capacity 75 MN
- Horizontal load capacity 20 MN
- Dynamic Vertical load 75 MN
- Dynamic Horizontal load 6 MN
- Dynamic Horizontal stroke 1200 mm
- Peak horizontal velocity 1000 mm/s

The tests are performed in accordance to the specific requirement of the standard EN 15129 or other applicable standard for the specific project and normally include the following tests:

- Vertical load tests at zero displacement
- Evaluation of the vertical stiffness
- Evaluation of the horizontal stiffness and damping



The Hiron testing laboratory

CORROSION PROTECTION

The corrosion protection of all the external steel plates is normally performed in accordance with EN ISO 12944.

The working life of the protective coating system on the bearing can be assumed to be fulfilled with a protective system designed for the durability "high" of more than 15 years in accordance with EN ISO 12944-5:2007, 5.5 for corrosivity category C5-I (I=industrial) for inland locations and C5-M (M=marine) for sea side locations.

Surfaces in contact with concrete need no corrosion protection; however a layer of 50 μm of the first pack is applied in order to prevent oxidation during the storage before the installation. A return of at least 50 mm is applied.

In alternative paint will conform to the Project specifications, as specified by the purchaser.

© FIRE RESISTANCE

Rubber Isolators may be rendered fire resistant by adding a suitable shield. Utilizing the appropriate shield any duration of fire resistance may be achieved. After a fire event an inspection is recommended and, depending on the fire intensity, the Isolators may need to be replaced.

© FIXINGS

The HIDAMP and HILEAD isolators are provided with fixings made with bolts or dowels according to the type of structure. The fixing are connected to the isolator in such a way to allow the easy replacement if necessary.

© MATERIALS

HIRUN developed several types of rubber compounds in order to meet different design requirements. For the HDRB isolators 4 dissipating compounds are available:

- Low damping compound (L) with shear modulus $G=0,9 \text{ MPa}$ and damping 4% at 100% shear strain
- Soft compound (S) with shear modulus $G=0,4 \text{ MPa}$ and damping 10% at 100% shear strain
- Normal compound (N) with shear modulus $G=0,8 \text{ MPa}$ and damping 10% at 100% shear strain
- Hard compound (H) with shear modulus $G=1,4 \text{ MPa}$ and damping 16% at 100% shear strain

For the LRB normally a low damping compound (L) with shear modulus $G=0,9 \text{ MPa}$ is used

The mechanical properties of the different compounds are given in the following table:

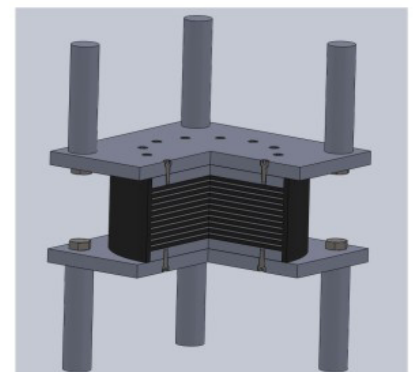
| Property | Unit | TYPE OF COMPOUND | | | |
|---|-------|------------------|-----|-----|-----|
| | | L | S | N | H |
| Shore hardness | Shore | 60 | 50 | 60 | 75 |
| Tensile strength | MPa | 12 | 12 | 12 | 12 |
| Elongation at failure | % | 400 | 400 | 400 | 400 |
| Equivalent viscous damping at 100% strain | % | 4 | 10 | 10 | 16 |

© HIGH DAMPING RUBBER BEARINGS

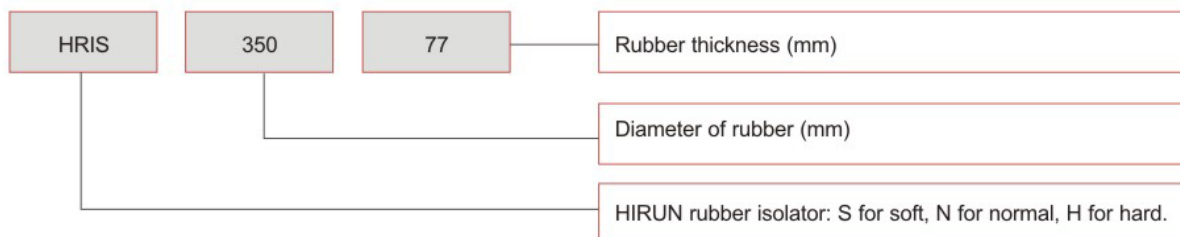
High damping rubber bearing (HDRB) consists of a series of rubber layers vulcanized to steel plates. They are suitable to bear big vertical loads with limited deflection, showing therefore a high vertical stiffness and to allow large horizontal movements with small reactions, showing therefore a low horizontal stiffness.

Thanks to their low horizontal stiffness, when installed below a building, they can greatly reduce the seismic actions by increasing its natural period.


HDRB are provided with external steel plates with anchors suitable to transfer the vertical and horizontal load to the structure.



PARAMETERS OF HDRB

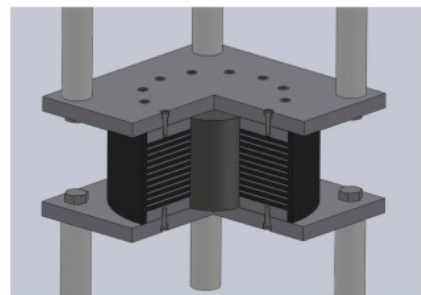


| Design displacement d=150 | | Rubber Diameter | Total Height | Rubber Thickness | Mounting Plate Dimension | Horizontal Stiffness | Vertical Load ULS | Seismic Vertical Load | Damping |
|------------------------------|-------------|--------------------|--------------|---------------------|-----------------------------|-------------------------|----------------------|--------------------------|---------|
| Types | | mm | mm | mm | mm | kN/mm | kN | kN | |
| Soft | HRIS-350-77 | 350 | 227 | 77 | 400X400 | 0.50 | 2400 | 1440 | 10% |
| | HRIS-400-77 | 400 | 227 | 77 | 450X450 | 0.65 | 3100 | 1860 | 10% |
| | HRIS-450-77 | 450 | 226 | 80 | 500X500 | 0.80 | 3900 | 2340 | 10% |
| | HRIS-500-77 | 500 | 223 | 81 | 550X550 | 0.97 | 4900 | 2940 | 10% |
| | HRIS-550-77 | 550 | 218 | 80 | 600X600 | 1.19 | 5900 | 3540 | 10% |
| | HRIS-600-77 | 600 | 218 | 80 | 650X650 | 1.41 | 7000 | 4200 | 10% |
| | HRIS-650-77 | 650 | 211 | 77 | 700X700 | 1.72 | 8200 | 4920 | 10% |
| | HRIS-700-77 | 700 | 202 | 72 | 750X750 | 2.14 | 9600 | 5760 | 10% |
| | HRIS-750-77 | 750 | 201 | 75 | 800X800 | 2.36 | 11000 | 6600 | 10% |
| | HRIS-800-77 | 800 | 201 | 75 | 850X850 | 2.68 | 12500 | 7500 | 10% |
| Normal | HRIN-350-77 | 350 | 227 | 77 | 400X400 | 1.00 | 2400 | 1440 | 10% |
| | HRIN-400-77 | 400 | 227 | 77 | 450X450 | 1.31 | 3100 | 1860 | 10% |
| | HRIN-450-80 | 450 | 226 | 80 | 500X500 | 1.59 | 3900 | 2340 | 10% |
| | HRIN-500-72 | 500 | 210 | 72 | 550X550 | 2.18 | 4900 | 2940 | 10% |
| | HRIN-550-80 | 550 | 218 | 80 | 600X600 | 2.38 | 5900 | 3540 | 10% |
| | HRIN-600-80 | 600 | 218 | 80 | 650X650 | 2.83 | 7000 | 4200 | 10% |
| | HRIN-650-77 | 650 | 211 | 77 | 700X700 | 3.45 | 8200 | 4920 | 10% |
| | HRIN-700-72 | 700 | 202 | 72 | 750X750 | 4.28 | 9600 | 5760 | 10% |
| | HRIN-750-75 | 750 | 201 | 75 | 800X800 | 4.71 | 11000 | 6600 | 10% |
| | HRIN-800-75 | 800 | 201 | 75 | 850X850 | 5.36 | 12500 | 7500 | 10% |
| Hard | HRIH-350-77 | 350 | 227 | 77 | 400X400 | 1.75 | 2400 | 1440 | 15% |
| | HRIH-400-77 | 400 | 227 | 77 | 450X450 | 2.28 | 3100 | 1860 | 15% |
| | HRIH-450-80 | 450 | 226 | 80 | 500X500 | 2.78 | 3900 | 2340 | 15% |
| | HRIH-500-72 | 500 | 210 | 72 | 550X550 | 3.82 | 4900 | 2940 | 15% |
| | HRIH-550-80 | 550 | 218 | 80 | 600X600 | 4.16 | 5900 | 3540 | 15% |
| | HRIH-600-80 | 600 | 218 | 80 | 650X650 | 4.95 | 7000 | 4200 | 15% |
| | HRIH-650-77 | 650 | 211 | 77 | 700X700 | 6.03 | 8200 | 4920 | 15% |
| | HRIH-700-72 | 700 | 202 | 72 | 750X750 | 7.48 | 9600 | 5760 | 15% |
| | HRIH-750-75 | 750 | 201 | 75 | 800X800 | 8.25 | 11000 | 6600 | 15% |
| | HRIH-800-75 | 800 | 201 | 75 | 850X850 | 9.38 | 12500 | 7500 | 15% |

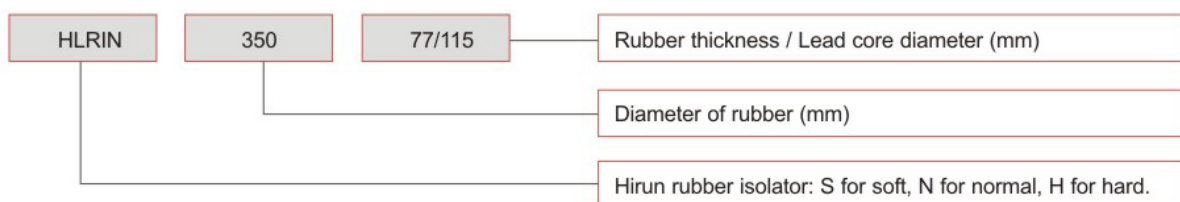
|  | | <div> <div>HIDAMP – HILEAD</div> <div>HDRB – LRB ISOLATORS</div> </div> | | | | | | | |
|---|--------------|---|--------------|---------------------|-----------------------------|-------------------------|----------------------|--------------------------|---------|
| Design displacement d=200 | | Rubber Diameter | Total Height | Rubber Thickness | Mounting Plate Dimension | Horizontal Stiffness | Vertical Load ULS | Seismic Vertical Load | Damping |
| Types | | mm | mm | mm | mm | kN/mm | kN | kN | |
| Soft | HRIS-350-105 | 350 | 271 | 105 | 400X400 | 0.37 | 2400 | 1440 | 10% |
| | HRIS-400-105 | 400 | 271 | 105 | 450X450 | 0.48 | 3100 | 1860 | 10% |
| | HRIS-450-104 | 450 | 262 | 104 | 500X500 | 0.61 | 3900 | 2340 | 10% |
| | HRIS-500-99 | 500 | 249 | 99 | 550X550 | 0.79 | 4900 | 2940 | 10% |
| | HRIS-550-100 | 550 | 246 | 100 | 600X600 | 0.95 | 5900 | 3540 | 10% |
| | HRIS-600-100 | 600 | 246 | 100 | 650X650 | 1.13 | 7000 | 4200 | 10% |
| | HRIS-650-99 | 650 | 241 | 99 | 700X700 | 1.34 | 8200 | 4920 | 10% |
| | HRIS-700-96 | 700 | 234 | 96 | 750X750 | 1.60 | 9600 | 5760 | 10% |
| | HRIS-750-98 | 750 | 232 | 98 | 800X800 | 1.80 | 11000 | 6600 | 10% |
| | HRIS-800-98 | 800 | 232 | 98 | 850X850 | 2.05 | 12500 | 7500 | 10% |
| Normal | HRIN-350-105 | 350 | 271 | 105 | 400X400 | 0.73 | 2400 | 1440 | 10% |
| | HRIN-400-105 | 400 | 271 | 105 | 450X450 | 0.96 | 3100 | 1860 | 10% |
| | HRIN-450-104 | 450 | 262 | 104 | 500X500 | 1.22 | 3900 | 2340 | 10% |
| | HRIN-500-99 | 500 | 249 | 99 | 550X550 | 1.59 | 4900 | 2940 | 10% |
| | HRIN-550-100 | 550 | 246 | 100 | 600X600 | 1.90 | 5900 | 3540 | 10% |
| | HRIN-600-100 | 600 | 246 | 100 | 650X650 | 2.26 | 7000 | 4200 | 10% |
| | HRIN-650-99 | 650 | 241 | 99 | 700X700 | 2.68 | 8200 | 4920 | 10% |
| | HRIN-700-96 | 700 | 234 | 96 | 750X750 | 3.21 | 9600 | 5760 | 10% |
| | HRIN-750-98 | 750 | 232 | 98 | 800X800 | 3.61 | 11000 | 6600 | 10% |
| | HRIN-800-98 | 800 | 232 | 98 | 850X850 | 4.10 | 12500 | 7500 | 10% |
| Hard | HRIH-350-105 | 350 | 271 | 105 | 400X400 | 1.28 | 2400 | 1440 | 15% |
| | HRIH-400-105 | 400 | 271 | 105 | 450X450 | 1.68 | 3100 | 1860 | 15% |
| | HRIH-450-104 | 450 | 262 | 104 | 500X500 | 2.14 | 3900 | 2340 | 15% |
| | HRIH-500-99 | 500 | 249 | 99 | 550X550 | 2.78 | 4900 | 2940 | 15% |
| | HRIH-550-100 | 550 | 246 | 100 | 600X600 | 3.33 | 5900 | 3540 | 15% |
| | HRIH-600-100 | 600 | 246 | 100 | 650X650 | 3.96 | 7000 | 4200 | 15% |
| | HRIH-650-99 | 650 | 241 | 99 | 700X700 | 4.69 | 8200 | 4920 | 15% |
| | HRIH-700-96 | 700 | 234 | 96 | 750X750 | 5.61 | 9600 | 5760 | 15% |
| | HRIH-750-98 | 750 | 232 | 98 | 800X800 | 6.31 | 11000 | 6600 | 15% |
| | HRIH-800-98 | 800 | 232 | 98 | 850X850 | 7.18 | 12500 | 7500 | 15% |

◎ LEAD RUBBER BEARINGS (LRB)

Lead Rubber Bearings are similar to the HDRB, however the utilized rubber is not dissipating energy. The energy dissipation is obtained through one or more lead cores. The lead (99,9 % pure) is able to undergo many yield cycles without damage. After the yield cycles it re-crystallize and is ready to perform more yield cycles for unlimited times.



◎ PARAMETERS OF LRB



| Design displacement d=150 | | Rubber Diameter | Lead Diameter | Total Height | Rubber Thickness | Mounting Plate Dimension | Horizontal Stiffness of Isolator | Horizontal Stiffness of Lead | Horizontal Stiffness of Rubber | Vertical Load ULS | Seismic Vertical Load | Damping |
|------------------------------|------------------|--------------------|------------------|--------------|---------------------|-----------------------------|--|------------------------------------|--------------------------------------|-------------------------|-----------------------------|---------|
| Types | | mm | mm | mm | mm | mm | kN/mm | kN/mm | kN/mm | kN | kN | |
| Normal | HLRIN-350-77/115 | 350 | 115 | 247 | 77 | 400X400 | 1.65 | 17.54 | 1.00 | 2400 | 1440 | 30% |
| | HLRIN-400-77/130 | 400 | 130 | 247 | 77 | 450X450 | 2.14 | 22.41 | 1.31 | 3100 | 1860 | 30% |
| | HLRIN-450-80/145 | 450 | 145 | 244 | 80 | 500X500 | 2.64 | 26.83 | 1.60 | 3900 | 2340 | 30% |
| | HLRIN-500-72/160 | 500 | 160 | 224 | 72 | 550X550 | 3.54 | 36.30 | 2.20 | 4900 | 2940 | 30% |
| | HLRIN-550-80/180 | 550 | 180 | 252 | 80 | 600X600 | 3.98 | 41.35 | 2.39 | 5900 | 3540 | 30% |
| | HLRIN-600-80/195 | 600 | 195 | 252 | 80 | 650X650 | 4.71 | 44.53 | 2.84 | 7000 | 4200 | 30% |
| | HLRIN-650-77/210 | 650 | 210 | 243 | 77 | 700X700 | 5.64 | 58.48 | 3.47 | 8200 | 4920 | 30% |
| | HLRIN-700-72/230 | 700 | 230 | 232 | 72 | 750X750 | 7.06 | 75.02 | 4.29 | 9600 | 5760 | 30% |
| | HLRIN-750-75/245 | 750 | 245 | 229 | 75 | 800X800 | 7.88 | 81.72 | 4.74 | 11000 | 6600 | 30% |
| | HLRIN-800-75/260 | 800 | 260 | 229 | 75 | 850X850 | 8.93 | 92.03 | 5.39 | 12500 | 7500 | 30% |

| Design displacement d=200 | | Rubber Diameter | Lead Diameter | Total Height | Rubber Thickness | Mounting Plate Dimension | Horizontal Stiffness of Isolator | Horizontal Stiffness of Lead | Horizontal Stiffness of Rubber | Vertical Load ULS | Seismic Vertical Load | Damping |
|------------------------------|-------------------|--------------------|------------------|--------------|---------------------|-----------------------------|--|------------------------------------|--------------------------------------|-------------------------|-----------------------------|---------|
| Types | | mm | mm | mm | mm | mm | kN/mm | kN/mm | kN/mm | kN | kN | |
| Normal | HLRIN-350-105/115 | 350 | 115 | 299 | 105 | 400X400 | 1.23 | 12.86 | 0.74 | 2400 | 1440 | 30% |
| | HLRIN-400-105/130 | 400 | 130 | 299 | 105 | 450X450 | 1.60 | 16.43 | 0.96 | 3100 | 1860 | 30% |
| | HLRIN-450-104/145 | 450 | 145 | 286 | 104 | 500X500 | 2.02 | 20.64 | 1.23 | 3900 | 2340 | 30% |
| | HLRIN-500-99/160 | 500 | 160 | 269 | 99 | 550X550 | 2.61 | 26.40 | 1.60 | 4900 | 2940 | 30% |
| | HLRIN-550-100/180 | 550 | 180 | 284 | 100 | 600X600 | 3.18 | 33.08 | 1.91 | 5900 | 3540 | 30% |
| | HLRIN-600-100/195 | 600 | 195 | 284 | 100 | 650X650 | 3.77 | 38.82 | 2.28 | 7000 | 4200 | 30% |
| | HLRIN-650-99/210 | 650 | 210 | 277 | 99 | 700X700 | 4.43 | 45.48 | 2.70 | 8200 | 4920 | 30% |
| | HLRIN-700-96/230 | 700 | 230 | 268 | 96 | 750X750 | 5.30 | 56.26 | 3.22 | 9600 | 5760 | 30% |
| | HLRIN-750-98/245 | 750 | 245 | 264 | 98 | 800X800 | 5.98 | 62.54 | 3.62 | 11000 | 6600 | 30% |
| | HLRIN-800-98/260 | 800 | 260 | 264 | 98 | 850X850 | 6.78 | 70.43 | 4.13 | 12500 | 7500 | 30% |



Temburong Bridge - Brunei



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