

KOHRANG INDUSTRIAL GROUP

Think Big & Make Your Dreams Reality

KOHRANG

Seismic Isolation Bearings



Technical Information and Dimensions

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KOHRANG INDUSTRIAL GROUP established in 1986 consists of KOHRANG Lastic, KOHRANG Baspar, KOHRANG Niroo, Gostaresh Fanavari KOHRANG, SAZANDISH, and Pars Bandar companies. Each company has individual attributes in terms of the background, products, services, and type of the activities and the whole group is being managed by the board of directors. The industrial group operates in ten industrial sheds in a lot over 32,000 m² located in Oshtorjan industrial town, Isfahan, Iran. The industrial group produces various kinds of rubber, metal, and polyurethane parts to be used in civil, marine, steel, mines, and oil industries. Almost half a century of invaluable experiences, a team of highly skilled, and dedicated and innovative personnel have enabled us to deliver solutions to the most demanding operational and technical challenges requested by the most national and international clients.

KOHRANG Lastic Company designs and manufactures heavy and super heavy rubber parts such as structural and seismic isolation bearings (i.e., elastomeric bearings, lead rubber bearings – LRB, and high damping rubber bearings – HDRB), elastomeric expansion joints, various kinds of marine rubber fenders (e.g., cell fenders, cone fenders, V-fenders, D-fenders, shock cells, and so on), frontal frames and its accessories, piggyback saddles, rubber dams, rubber impact protection parts, roller rubber coverings, hot and cold rubber linings of steel and concrete tanks, rubber mill linings, and railway anti-vibration mats.

SAZANDISH Company is the Engineering, Procurement and Construction (EPC) projects contractor in the field of steel making plants, materials handling systems, dust cooling and cleaning systems, dry dock gates, floating docks (Pontoon), offshore structures, marine buoys, and bollards.

Gostaresh Fanavari KOHRANG Company was established to do research and develop the technologies of polymer and petrochemical industries, and also to manufacture the innovative and modern products of berthing and mooring such as, quick release hooks, capstans, and fairleads.

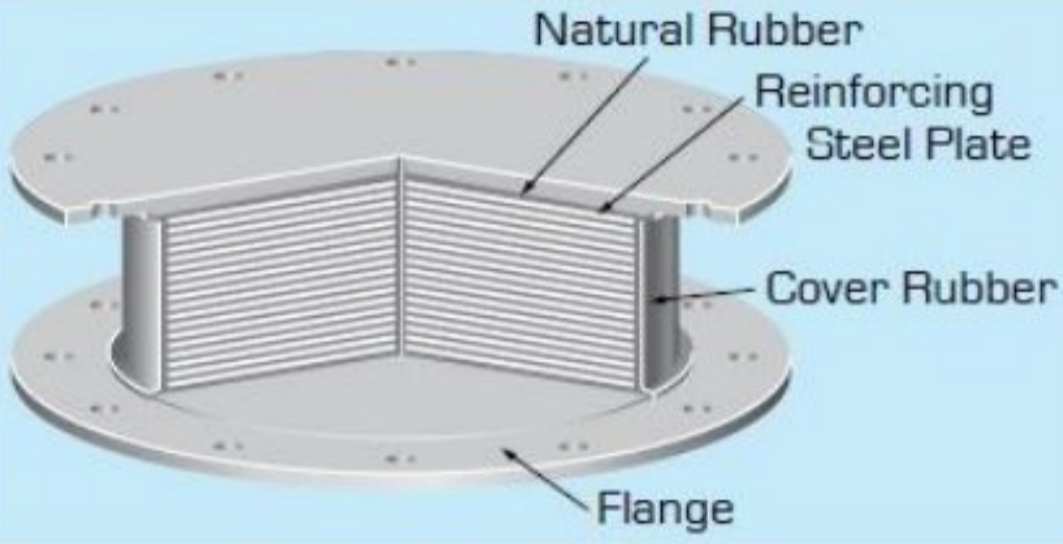
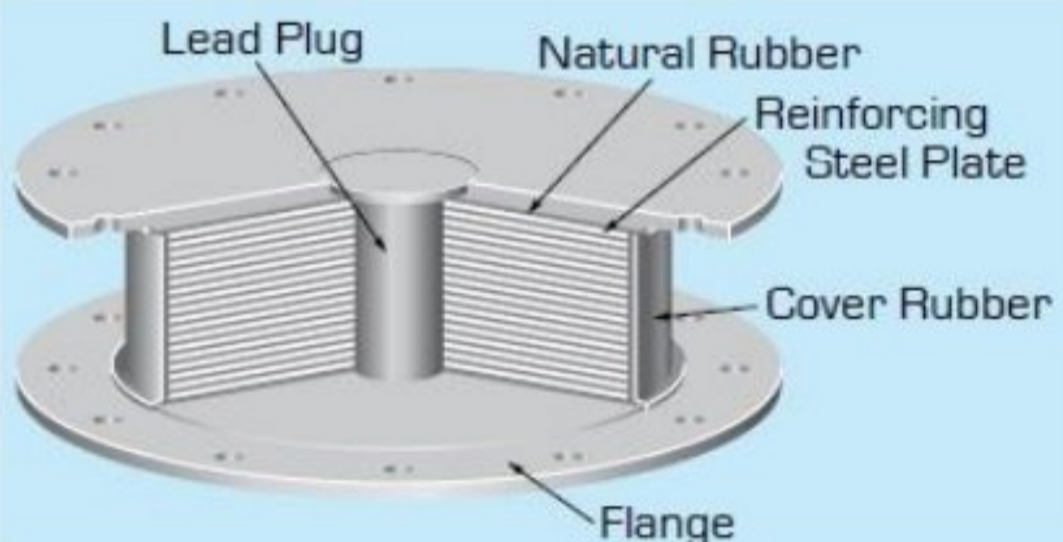
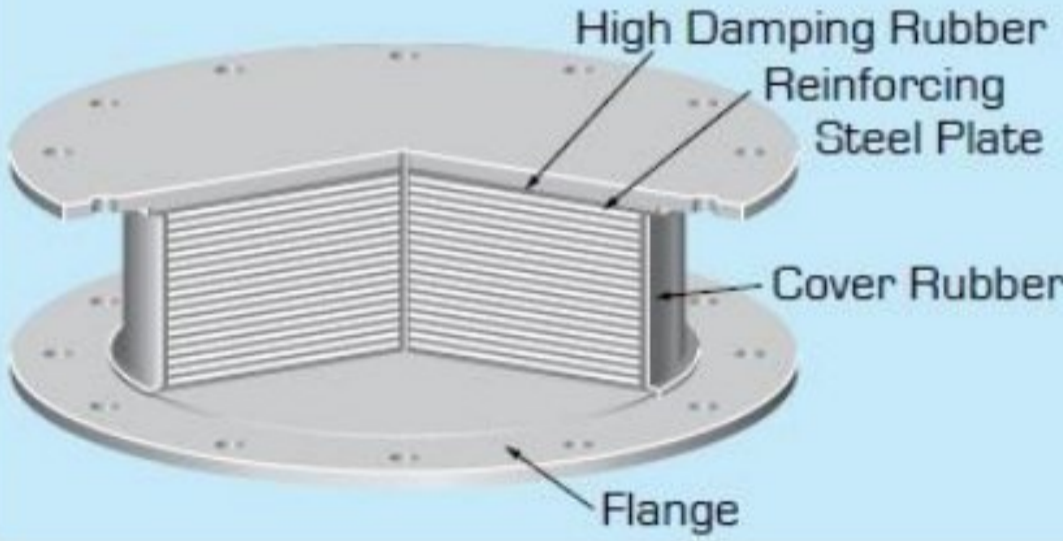
KOHRANG Baspar Company designs and manufactures all types of industrial polyurethane parts such as oil and gas pipeline pigs and the screens for the mining and steel industries.

KOHRANG Niroo Company does the engineering, constructing, and commissioning of the industrial plants equipment as well as the oil and gas pipelines.

Pars Bandar Company was established to develop the KOHRANG Lastic Company's products to come out with the special rubber parts.



KOHRANG Seismic Isolation Products

PRODUCT	FEATURES	SECTIONAL VIEW
<p>NRB Natural Rubber Bearing</p>	<p>Natural rubber with inherently low damping ratio (about 5% equivalent damping ratio) is being used for this type of bearing. NRB has excellent linearity and stable restoring force. In order to increase the overall damping ratio, a separate damper would be required. In this case, the isolation design will have much greater flexibility. KOHRANG manufactures different kinds of NRBs with various dimensions to support a wide range of vertical and horizontal loads.</p>	
<p>LRB Lead Rubber Bearing</p>	<p>This type of bearing includes a lead plug embedded at the center of a reinforced natural rubber bearing (known as Neoprene). The rubber component incorporates the spring capability and vertical loading capacity, while the lead plug provides appropriate damping capability. LRBs would be a good choice for areas with space constraints as any separate damper is not required, generally. The hysteresis loops of LRBs show an elastoplastic behavior. The attenuation of the transmitted seismic forces can be tuned by varying the lead plug diameter.</p>	
<p>HDRB High Damping Rubber Bearing</p>	<p>High damping rubber with inherently moderate damping ratio (about 17 to 24% equivalent damping ratio) includes both spring and damping characteristics. Similarly to the LRBs, separate damper devices are not required, and thus make it an excellent choice for areas with space constraints. The HDRB seismic isolation systems can also be extended to the equipment inside the buildings, as their hysteresis curves are relatively smooth. KOHRANG HDRBs are being produced in different dimensions and specifications to satisfy any requirement from our clients.</p>	



KOHRANG Elastomeric Bearings

In order to bearing river, rail, and road bridges in any weather conditions in many parts of the world, the both natural and synthetic (neoprene) rubber bearings also known as elastomeric bearings are presenting excellent services and demonstrating appropriate durability and efficiency. Compare to the alternative metal roller types, elastomeric bearings have distinct advantages such as easier installation, free from corrosion, and requiring no maintenance.

The elastomeric bearings allow the vertical loads (e.g., the dead load of the bridge deck and the live load of traffic on that) to be carried by the rubber in compression and the horizontal deflections by the rubber in shear. The high vertical stiffness of the laminated rubber-steel bearings is achieved by the inserted horizontal metal plates, which do not have any effect on the required low horizontal stiffness.

The durability property of elastomeric bearings is achieved by either the low ratio of surface to volume of rubber or the inclusion of protective chemicals. The later increases the resistance to weathering. Regarding to the years of experiences, the service lives of large natural rubber components does not affect by weathering.

The system of elastomeric bearing isolation is the forefront of these applications due to its lower cost and remarkable effect of mitigating the horizontal ground motion effects on superstructures. Its highly effective performance has been determined by the appropriate physical properties of natural rubber.

KOHRANG Lastic Company with more than a quarter of century experience and possession technical knowledge is a leader in manufacturing of all kinds of structural and seismic rubber bearings. This company is the manufacturer of the biggest elastomeric bearing with the dimensions of $900 \times 900 \times 378$ mm in Iran and the Middle East. KOHRANG Lastic designs, manufactures, tests, and supplies all types of elastomeric bearings to meet all international standards specifications such as; BS, EN, AASHTO, DIN, and ISO. The KOHRANG elastomeric bearings are unique and resistance in all weather conditions.



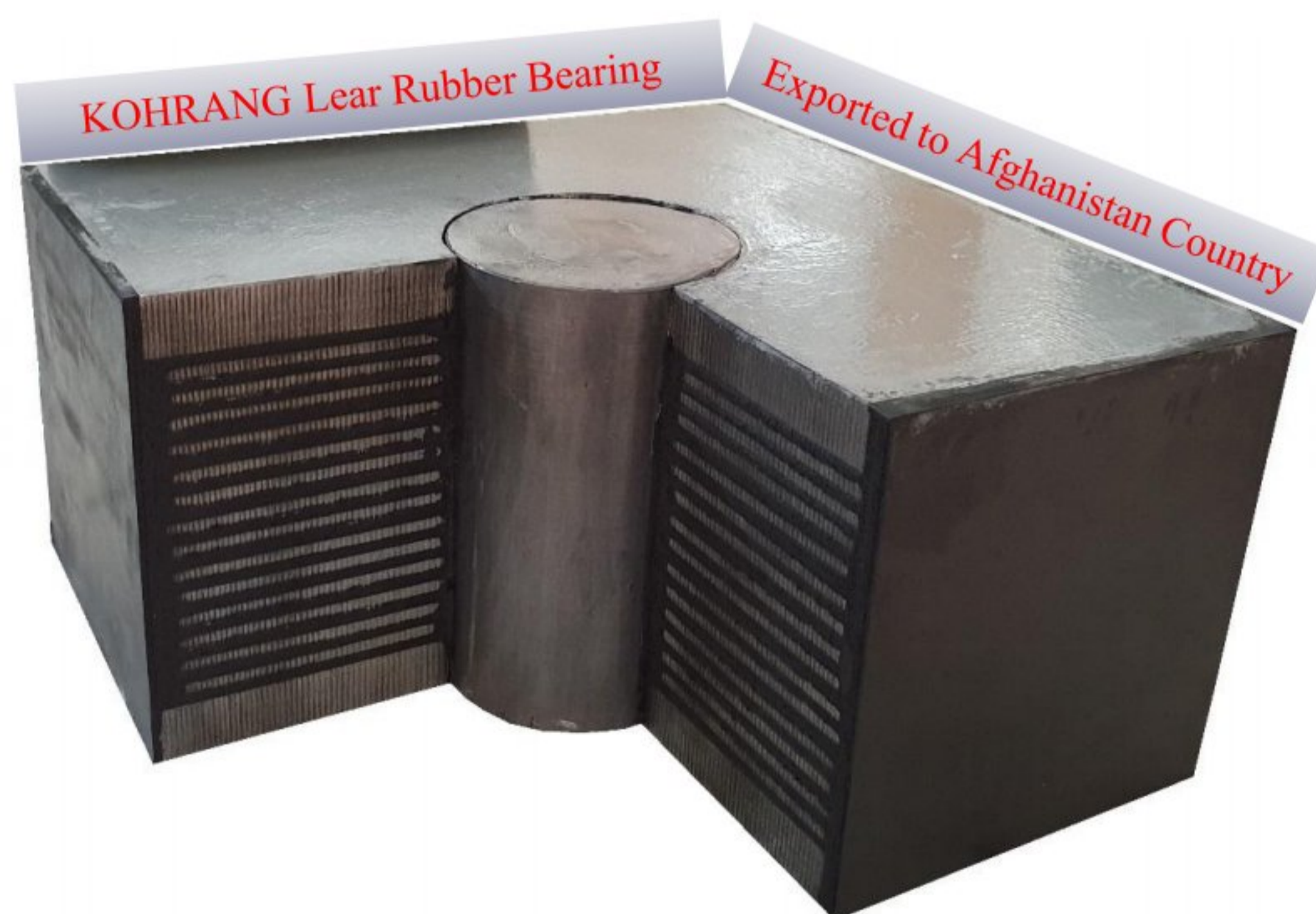
**The biggest Rubber-Bonded Steel Laminated Bearings
manufactured in Iran and the Middle East**



KOHRANG Lead Rubber Bearings

Lead rubber bearing as one of the well-known structural seismic protection devices works on the principles of base isolation and reduces the earthquake-induced forces transferred to the structure. Similar to regular natural rubber bearing, LRB consists of a laminated rubber and steel bearing with steel connection plates, but equipped by one or several energy dissipating lead cores. The weight of the structure would be supported by its high vertical stiffness characteristic provided by the thin layers of rubber reinforced by steel shims. The rubber layers act as spring and provide the isolation and re-centering the bearing after an earthquake event. The lead core(s) will undergo plastic deformation, generate heat, and dissipate the seismic energy during an earthquake. Due to the high absorption capacity of the lead cores with a minimum purity of 99.9%, they provide a high level of damping of up to 30%. Lead rubber bearings have found wide range of applications in structures. KOHRANG lead rubber bearings are manufactured using high quality elastomeric material, vulcanized reinforcement steel plates, and lead core(s). The bearings act as regular elastomeric bearings under normal conditions.

KOHRANG Lastic Company designs, manufactures, tests, and supplies Lead rubber bearings to meet all international standards specifications such as; BS, EN, AASHTO, DIN, and ISO. The KOHRANG lead rubber bearings are proven, safe, and versatile.





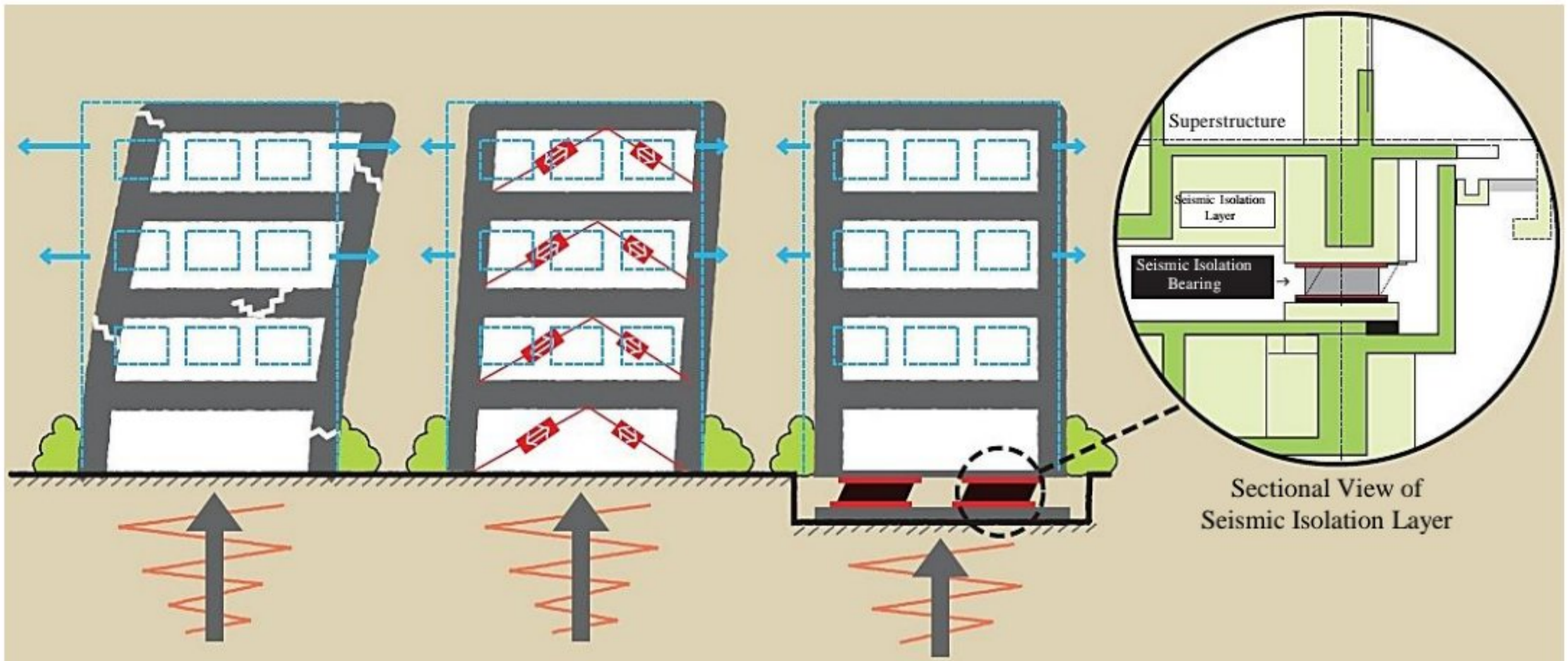
KOHRANG High Damping Rubber Bearings

Base isolation technology is a solution for significant projects in high-intensity seismic regions such as Iran country due to the simplicity of its application, notable improvement of the structural seismic response, and long term economic benefit in that areas. The established and accepted technology of base isolation has been widely used in bridges and structures all over the world. Seismic (or base) isolation offers remarkable advantages compare to the conventional protection methods by reducing the earthquake-induced forces transmitted into a structure. Base isolation functions mainly based on increasing the structural natural period and reducing the transmitted earthquake-induced forces. Such a capability is significantly important for the buildings such as hospitals, emergency centers, museums, and advanced technology factories that need to have immediate occupancy seismic performance. Base isolation that separates the superstructure from the lower part of the structure requires the following characteristics:

- Low horizontal stiffness at design displacement;
- High vertical stiffness;
- Supporting the compression load of the structure weight over long term;
- Large horizontal displacement capacity during the design earthquake and supporting the vertical load simultaneously;
- Appropriate level of damping;
- Re-centering the structure after an earthquake;
- Damping and stable stiffness properties over long term;
- High initial horizontal stiffness to support wind excitations;
- Re-functioning after the design earthquake.

KOHRANG High damping rubber bearings work on the principles of base isolation and are simple, cost-effective, and maintenance-free and have the capability to support the design earthquake loads without significant damage. They are similar to natural rubber bearings with steel connection plates. The difference is the used elastomer material, which has a special composition and ability to dissipate seismic energy by generation of deformation and heat.

KOHRANG Lastic Company designs, manufactures, tests, and supplies high damping rubber bearings to meet all international standards specifications such as; BS, EN, AASHTO, DIN, and ISO. The KOHRANG high damping rubber bearings are adaptable, effective, and safe.



Conventional Fixed-Base System

Absorb transmitted earthquake-induced forces by deformation of beams and columns

Vibration Controlled System

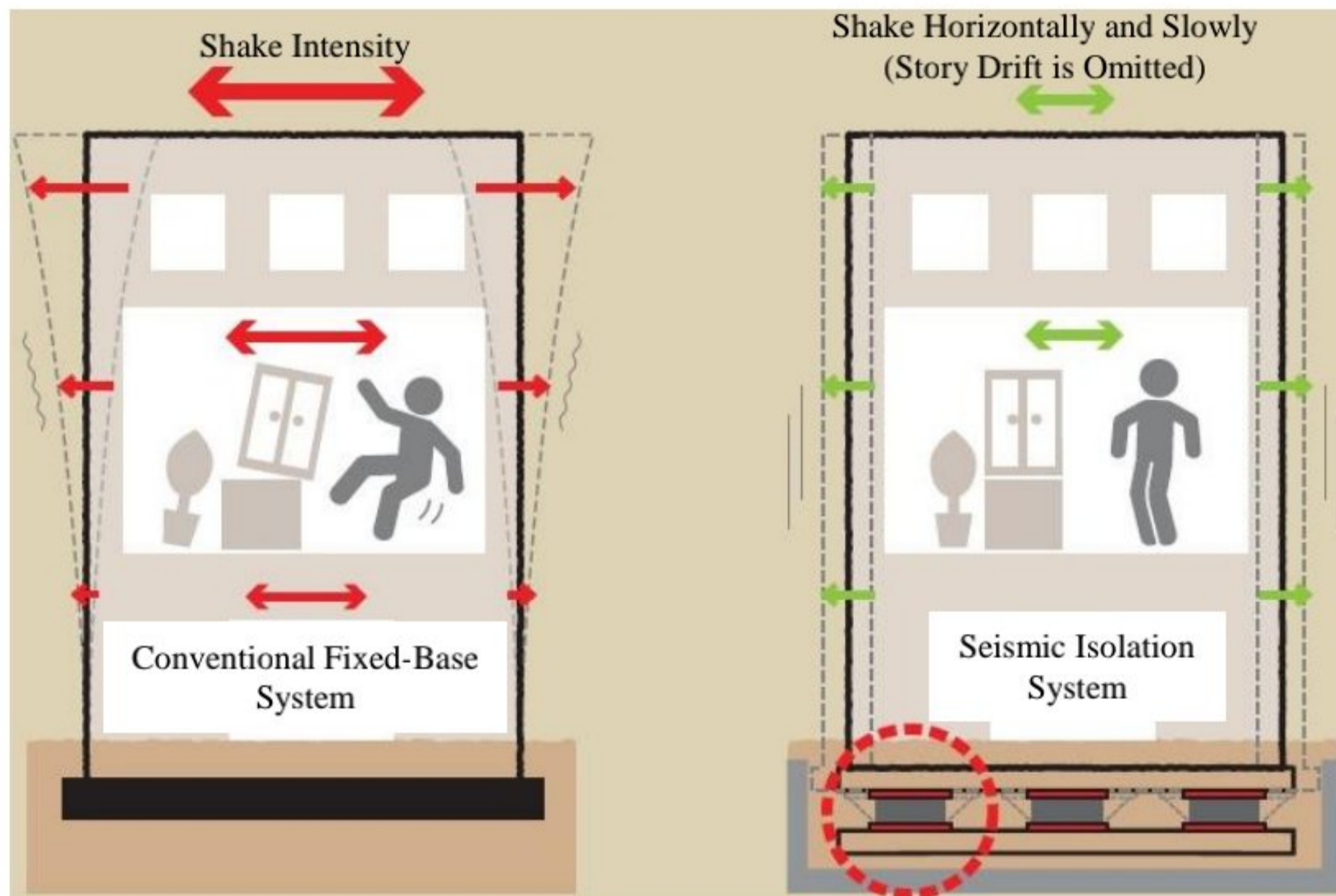
Absorb transmitted earthquake-induced forces by the installed damping system in the superstructure

Seismic Isolation System

Absorb transmitted earthquake-induced forces by the seismic isolation system which decouples superstructure from ground

Merit of Seismic Isolation System

Seismic isolation system is design to protect life, live ability, property, and functionality by controlling the transmission of ground-motion to the superstructure.



Able to ensure safety during earthquake by reducing the story drift remarkably

Prevent secondary disaster due to falling and damage of furniture and fixtures

Control damage of structural components such as beams and columns

Seismic isolation bearing absorbs vibration energy (ground shaking)



Features of KOHRANG Seismic Isolation Bearings



QUALITY CONTROL

Materials are produced by technology through years of researching in KOHRANG domestic plant. KOHRANG deals with wide range of sizes from small dimensions and diameter. We own the complete testing evaluation facility.

DURABILITY

KOHRANG's seismic isolation bearings have the durability for more than 50 years. Inner rubber is integrally molded with special cover rubber on surface, which can suppress the deterioration and improve the durability. This rubber cover is specially developed for seismic isolation and it has incorporated with over 35 years of KOHRANG's rubber technology.



COST/FINANCE VALUE

In seismic isolated buildings, the construction cost would be increased due to the seismic isolation layer section. However, as the structural seismic responses are reduced, the cost of work on superstructure can be reduced remarkably. Generally, it has been proved that it is only few percent (%) higher in term of the total construction cost. However, the total building cost is not only the initial cost. Considering the upgraded seismic performance level and the relevant costs in terms of the valuable furniture cost and specially the lifecycle cost which is overall running cost including safety, live ability, securing the asset, and etc., the seismic isolated buildings have more advantages.



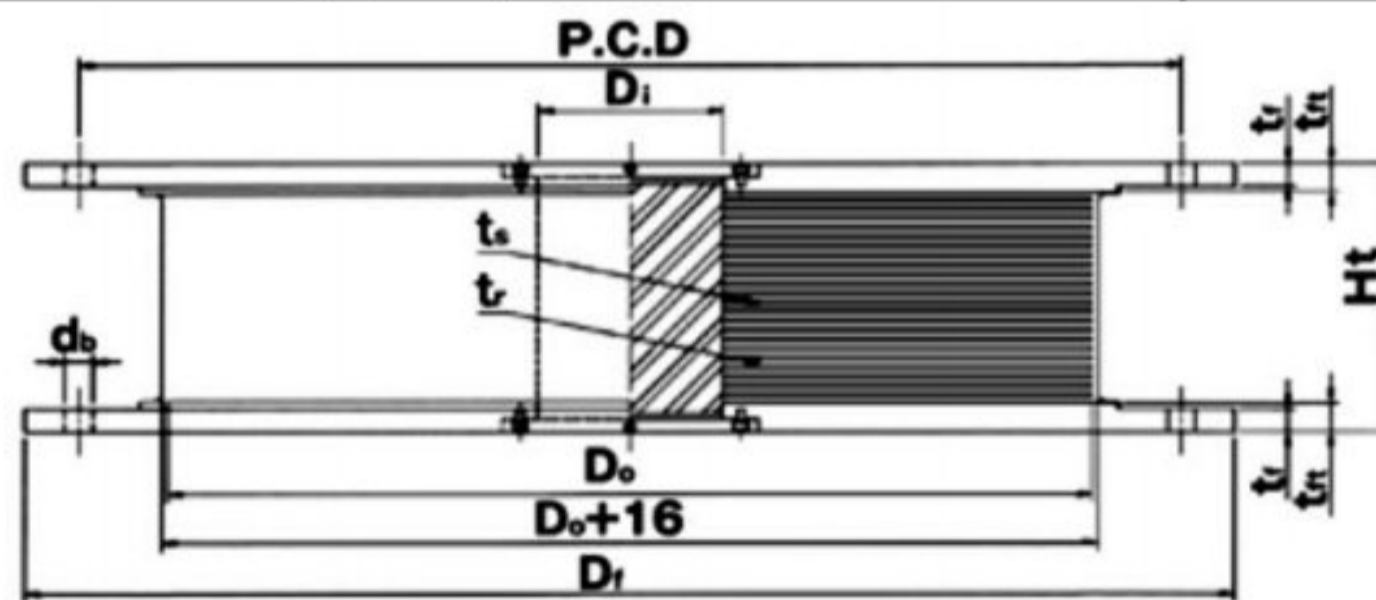


Product Specification

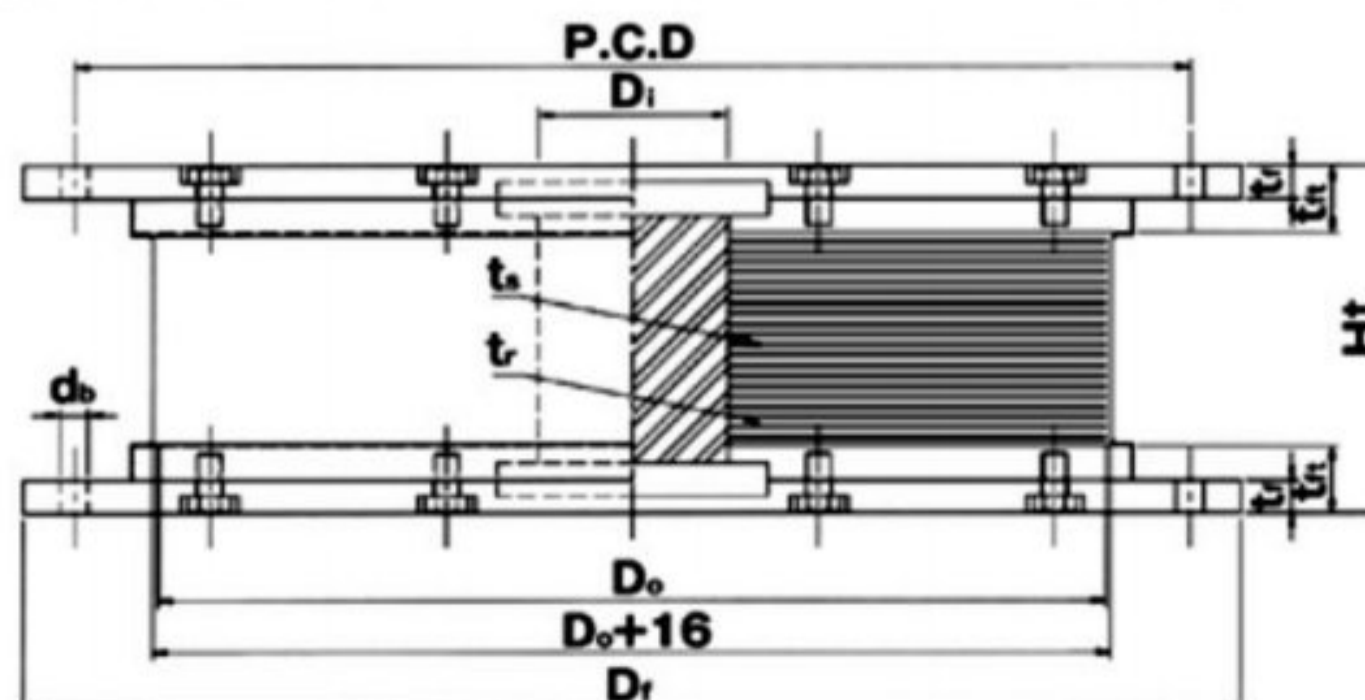
Lead Rubber Bearing (LRB)

This type of seismic isolation bearing includes a lead plug embedded at the center of a laminated natural rubber structure, where the rubber incorporates the spring capability and the lead plug provides the damping capability. Its hysteresis diagram shows a behavior similar to the elasto-plastic materials. The damping capacity can be adjusted by varying the lead plug diameter.

Characteristics	
D_o (mm)	Outer diameter
D_i (mm)	Lead plug diameter
n_i	Number of lead plugs
A (mm ²)	Effective plane area
t_r (mm)	Thickness of one rubber layer
n	Number of rubber layers
$H = n \times t_r$ (mm)	Total rubber thickness
$S_1 = (D_o^2 - n_i \times D_i^2) / (4 \times t_r \times (D_o + n_i \times D_i))$	First shape factor
$S_2 = D_o / (n \times t_r)$	Second shape factor
D_f (mm)	Flange diameter
t_f / t_{ft}	Flange thickness (edge / center)
PCD (mm)	Connecting bolt Pitch Circle Diameter (PCD)
d_b (mm)	Connecting bolt hole diameter
t_s (mm)	Reinforced steel plate thickness
H_t (mm)	Total height



Integrated Type Flange



Assembled Type Flange

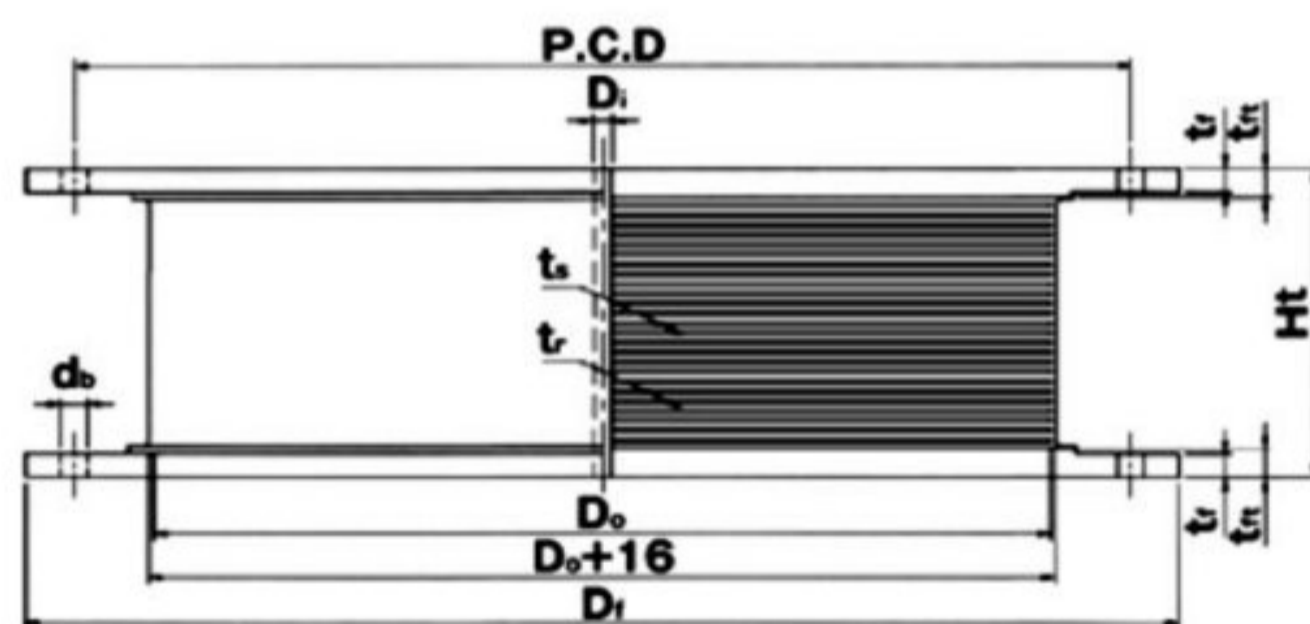


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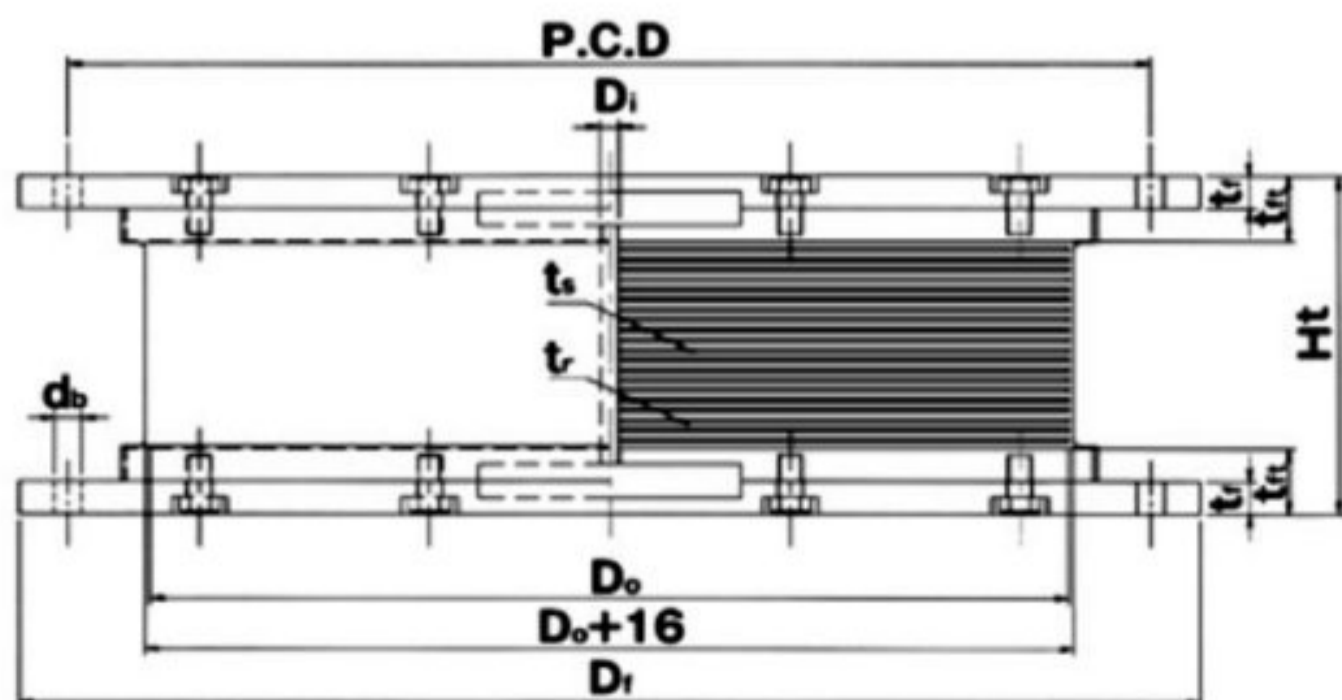
High Damping Rubber Bearing (HDRB)

High damping rubber bearing is a laminated rubber structure that includes a special filler compound in the rubber itself to provide energy absorption performance. It combines damping and spring characteristics and is widely adopted as a seismic isolator.

Characteristics	
D_o (mm)	Outer diameter
A (mm ²)	Effective plane area
t_r (mm)	Thickness of one rubber layer
n	Number of rubber layers
$H = n \times t_r$ (mm)	Total rubber thickness
$S_1 = D_o/4 \times t_r$	First shape factor
$S_2 = D_o/(n \times t_r)$	Second shape factor
D_f (mm)	Flange diameter
t_f / t_{ft}	Flange thickness (edge / center)
PCD (mm)	Connecting bolt Pitch Circle Diameter (PCD)
d_b (mm)	Connecting bolt hole diameter
t_s (mm)	Reinforced steel plate thickness
H_t (mm)	Total height



Integrated Type Flange



Assembled Type Flange



Rubber Selection Data Chart

SPECIFICATIONS	NATURAL RUBBER	SBR	EPDM	NEOPERENE CR	NITRILE NBR	PU
Cost Factor	1	1	1	2	2	3
Hardness Range	30-95°	40-95°	30-85°	30-90°	40-100°	10 _{Shore A} 85 _{Shore D}
Colors	Full Range	Full Range	Limited Range	Full Range	Limited Range	Limited Range
Heat Resistance (°C)						
Maximum Continuous	75°C	85°C	130°C	95°C	100°C	75°C
Maximum Intermittent	105°C	115°C	150°C	125°C	130°C	150°C
Low Temperature Resistance	-60°C	-55°C	-50°C	-40°C	-20°C	-68°C
Resistances						
Oxidation	Fair	Fair	Excellent	Very Good	Good	Excellent
Ozone & Weathering	Poor	Poor	Outstanding	Very Good	Fair	Outstanding
Oil Resistance						
*ASTM Oil No. 1@20°C	Poor	Poor	Fair	Excellent	Excellent	Excellent
@100°C	Unsatisfactory	Unsatisfactory	Unsatisfactory	Good	Good	Good
*ASTM Oil No. 3@20°C	Unsatisfactory	Unsatisfactory	Unsatisfactory	Good	Excellent	Excellent
@100°C	Unsatisfactory	Unsatisfactory	Unsatisfactory	Fair	Good	Good
Fuel Resistance						
*ASTM Fuel B@40°C	Unsatisfactory	Unsatisfactory	Unsatisfactory	Poor	Fair	Good
Chemical Resistance						
Acids	Fair	Fair	Good	Good	Good	Weak
Bases	Good	Good	Good	Fair	Fair	Weak
Physical Strength	Excellent	Good	Good	Good	Good	Excellent
Compression Set	Good	Good	Good	Fair to Good	Good	Good
Tear & Abrasion Resistance	Excellent	Good	Good	Good	Good	Exceptional
Resilience	Excellent	Good	Very Good	Very Good	Good	Excellent
Permeability To Gas	Poor	Fairly Low	Fairly Low	Low	Low	Fairly Low
Flame Resistance	Poor	Poor	Poor	Self-extinguishing	Poor	Poor
Water Resistance	Very Good	Good	Excellent	Good	Good	Excellent



Lead Rubber Bearing (LRB)

Total Rubber Thickness: 20cm										Specification		Shear Modulus (N/mm²)								
												0.385								
CHARACTERISTICS	KLRB060R20										KLRB065R20									
Outer Dia. (mm)	600										650									
Lead plug Dia. (mm)	80	90	100	110	120	130	140	150	160	90	100	120	120	130	140	150	160	170		
Effective area (x 10 ² mm ²)	2777	2764	2749	2732	2714	2695	2673	2651	2626	3255	3240	3223	3205	3186	3164	3142	3117	3091		
One rubber layer thickness (mm)	4.0										4.4									
Rubber layers No.	50										45									
Total rubber thickness (mm)	200										198									
1 st Shape factor	37.5										36.9									
2 nd Shape factor	3.00										3.28									
Flange Dia. (mm)	900										950									
Flange thickness (edge/center)	22/28										22/28									
Connecting bolt PCD (mm)	775										825									
Connecting bolt hole Dia. x qty	M30 - Ø33 x 12										M30 - Ø33 x 12									
Rein. steel plate Thickness (mm)	3.1										3.1									
Total height (mm)	407.9										390.4									
Total weight (kN) (1kN~100kg)	6.6	6.6	6.7	6.7	6.8	6.8	6.9	6.9	7.0	7.2	7.2	7.3	7.3	7.4	7.4	7.5	7.6	7.6		
Compressive stiffness (x10 ³ kN/m)	1670										1970									
Nominal long term column load (kN)	1670	1660	1650	1640	1630	1620	1600	1590	1580	2370	2360	2350	2330	2320	2300	2290	2270	2250		
Equivalent shear stiffness (x10 ³ kN/m)	0.749	0.804	0.865	0.932	1.01	1.09	1.17	1.27	1.37	0.908	0.969	1.04	1.11	1.19	1.28	1.37	1.47	1.58		
Equivalent damping ratio	0.165	0.193	0.219	0.244	0.266	0.285	0.302	0.317	0.329	0.174	0.199	0.223	0.246	0.266	0.284	0.300	0.314	0.326		



Total Rubber Thickness: 20cm

Specification	Shear Modulus (N/mm²)
	0.385

CHARACTERISTICS	KLRB070R20										KLRB075R20								
Outer Dia. (mm)	700										750								
Lead plug Dia. (mm)	100	110	120	130	140	150	160	170	180	110	120	130	140	150	160	170	180	190	
Effective area (x 10 ² mm ²)	3770	3753	3735	3716	3695	3672	3647	3621	3594	4323	4305	4285	4264	4241	4217	4191	4163	4134	
One rubber layer thickness (mm)	4.7										5.0								
Rubber layers No.	43										40								
Total rubber thickness (mm)	202										200								
1 st Shape factor	37.2										37.5								
2 nd Shape factor	3.46										3.75								
Flange Dia. (mm)	1000										1100								
Flange thickness (edge/center)	22/28										22/28								
Connecting bolt PCD (mm)	875										950								
Connecting bolt hole Dia. x qty	M30 - Ø33 x 12										M30 - Ø33 x 12								
Rein. steel plate Thickness (mm)	3.1										3.1								
Total height (mm)	388.3										376.9								
Total weight (kN) (1kN~100kg)	8.1	8.1	8.2	8.2	8.3	8.4	8.4	8.5	8.6	9.1	9.2	9.2	9.3	9.3	9.4	9.5	9.5	9.6	
Compressive stiffness (x10 ³ kN/m)	2250										2610								
Nominal long term column load (kN)	3050	3040	3020	3010	2990	2970	2950	2930	2910	4060	4040	4020	4000	3980	3960	3930	3910	3880	
Equivalent shear stiffness (x10 ³ kN/m)	1.05	1.12	1.19	1.27	1.36	1.45	1.55	1.65	1.76	1.24	1.31	1.39	1.48	1.57	1.67	1.78	1.89	2.01	
Equivalent damping ratio	0.181	0.205	0.227	0.247	0.266	0.283	0.298	0.311	0.323	0.187	0.209	0.229	0.248	0.266	0.282	0.296	0.309	0.320	

Total Rubber Thickness: 20cm

Specification	Shear Modulus (N/mm²)
	0.385

CHARACTERISTICS	KLRB080R20										KLRB085R20									
Outer Dia. (mm)	800										850									
Lead plug Dia. (mm)	120	130	140	150	160	170	180	190	200	120	130	140	150	160	170	180	190	200	210	220
Effective area (x 10 ² mm ²)	4913	4894	4873	4850	4825	4800	4772	4743	4712	5561	5542	5521	5498	5473	5448	5420	5391	5360	5328	5294
One rubber layer thickness (mm)	5.4										5.7									
Rubber layers No.	37										35									
Total rubber thickness (mm)	200										200									
1 st Shape factor	37.0										37.3									
2 nd Shape factor	4.0										4.26									
Flange Dia. (mm)	1150										1200									
Flange thickness (edge/center)	24/32										24/32									
Connecting bolt PCD (mm)	1000										1050									
Connecting bolt hole Dia. x qty	M30 - Ø33 x 12										M30 - Ø33 x 12									
Rein. steel plate thickness (mm)	4.4										4.4									
Total height (mm)	422.2										413.1									
Total weight (kN) (1kN~100kg)	12.2	12.3	12.3	12.4	12.5	12.5	12.6	12.7	12.8	13.2	13.2	13.3	13.4	13.4	13.5	13.6	13.7	13.7	13.8	13.9
Compressive stiffness (x10 ³ kN/m)	2960										3360									
Nominal long term column load (kN)	5180	5160	5130	5110	5080	5060	5030	5000	4960	6500	6480	6460	6430	6400	6370	6340	6300	6270	6230	6190
Equivalent shear stiffness (x10 ³ kN/m)	1.43	1.51	1.60	1.69	1.79	1.90	2.01	2.13	2.25	1.56	1.64	1.73	1.82	1.92	2.02	2.14	2.26	2.38	2.51	2.65
Equivalent damping ratio	0.193	0.213	0.232	0.250	0.266	0.281	0.294	0.306	0.317	0.178	0.198	0.216	0.234	0.251	0.266	0.280	0.293	0.304	0.315	0.324



Total Rubber Thickness: 20cm

Specification	Shear Modulus (N/mm²)
	0.385

CHARACTERISTICS	KLRB090R20												KLRB095R20											
Outer Dia. (mm)	900												950											
Lead plug Dia. (mm)	130	140	150	160	170	180	190	200	210	220	230	140	150	160	170	180	190	200	210	220	230	240		
Effective area (x 10 ² mm ²)	6229	6208	6185	6161	6135	6107	6078	6048	6015	5982	5946	6934	6912	6887	6861	6834	6805	6774	6742	6708	6673	6636		
One rubber layer thickness (mm)	6.0												6.4											
Rubber layers No.	33												31											
Total rubber thickness (mm)	198												198											
1 st Shape factor	37.5												37.1											
2 nd Shape factor	4.55												4.79											
Flange Dia. (mm)	1250												1300											
Flange thickness (edge/center)	28/36												28/36											
Connecting bolt PCD (mm)	1100												1150											
Connecting bolt hole Dia. x qty	M30 - Ø33 x 12												M30 - Ø33 x 12											
Rein. steel plate Thickness (mm)	4.4												4.4											
Total height (mm)	410.8												402.4											
Total weight (kN) (1kN~100kg)	14.9	15.0	15.1	15.1	15.2	15.3	15.4	15.4	15.5	15.6	15.7	16.0	16.1	16.2	16.2	16.3	16.4	16.5	16.6	16.6	16.7	16.8		
Compressive stiffness (x10 ³ kN/m)	3800												4210											
Nominal long term column load (kN)	8080	8060	8030	8000	7960	7930	7890	7850	7810	7760	7720	9010	8980	8950	8920	8880	8850	8810	8760	8720	8670	8630		
Equivalent shear stiffness (x10 ³ kN/m)	1.78	1.87	1.97	2.07	2.17	2.29	2.41	2.53	2.67	2.80	2.95	2.01	2.10	2.20	2.31	2.42	2.54	2.67	2.80	2.94	3.09	3.24		
Equivalent damping ratio	0.184	0.202	0.219	0.236	0.251	0.266	0.279	0.291	0.302	0.312	0.321	0.189	0.206	0.222	0.238	0.252	0.266	0.278	0.290	0.301	0.310	0.319		

Total Rubber Thickness: 20cm

Specification	Shear Modulus (N/mm²)
	0.385

CHARACTERISTICS	KLRB100R20												KLRB110R20											
Outer Dia. (mm)	1000												1100											
Lead plug Dia. (mm)	150	160	170	180	190	200	210	220	230	240	250	170	180	190	200	210	220	230	240	250	260	270		
Effective area (x 10 ² mm ²)	7677	7653	7627	7600	7570	7540	7508	7474	7439	7402	7363	9276	9249	9220	9189	9157	9123	9088	9051	9012	8972	8931		
One rubber layer thickness (mm)	6.7												7.4											
Rubber layers No.	30												27											
Total rubber thickness (mm)	201												200											
1 st Shape factor	37.3												37.2											
2 nd Shape factor	4.98												5.51											
Flange Dia. (mm)	1400												1500											
Flange thickness (edge/center)	28/36												30/38											
Connecting bolt PCD (mm)	1250												1350											
Connecting bolt hole Dia. x qty	M36 - Ø39 x 12												M36 - Ø39 x 12											
Rein. steel plate Thickness (mm)	4.4												4.4											
Total height (mm)	400.6												390.2											
Total weight (kN) (1kN~100kg)	17.8	17.9	18.0	18.0	18.1	18.2	18.3	18.4	18.5	18.6	18.7	20.7	20.8	20.9	21.0	21.0	21.1	21.2	21.3	21.4	21.5	21.6		
Compressive stiffness (x10 ³ kN/m)	4610												5600											
Nominal long term column load (kN)	11500	11500	11400	11400	11400	11300	11300	11200	11200	11100	11000	13900	13900	13800	13800	13700	13700	13600	13600	13500	13500	13400		
Equivalent shear stiffness (x10 ³ kN/m)	2.22	2.32	2.43	2.54	2.66	2.78	2.91	3.05	3.19	3.34	3.50	2.76	2.87	2.99	3.12	3.25	3.38	3.53	3.68	3.84	4.00	4.17		
Equivalent damping ratio	0.193	0.209	0.224	0.239	0.253	0.266	0.278	0.289	0.299	0.309	0.317	0.200	0.215	0.229	0.242	0.254	0.266	0.277	0.287	0.297	0.305	0.313		



Total Rubber Thickness: 20cm

Specification	Shear Modulus (N/mm ²)
	0.385

CHARACTERISTICS	KLRB120R20												
Outer Dia. (mm)	1200												
Lead plug Dia. (mm)	180	190	200	210	220	230	240	250	260	270	280	290	300
Effective area (x 10 ² mm ²)	11055	11026	10996	10963	10930	10894	10857	10819	10779	10737	10694	10649	10603
One rubber layer thickness (mm)	8.0												
Rubber layers No.	25												
Total rubber thickness (mm)	200												
1 st Shape factor	37.5												
2 nd Shape factor	6.00												
Flange Dia. (mm)	1600												
Flange thickness (edge/center)	32/40												
Connecting bolt PCD (mm)	1450												
Connecting bolt hole Dia. x qty	M36 - Ø39 x 12												
Rein. steel plate Thickness (mm)	4.4												
Total height (mm)	385.6												
Total weight (kN) (1kN~100kg)	24.0	24.1	24.2	24.3	24.3	24.4	24.5	24.6	24.7	24.9	25.0	25.1	25.2
Compressive stiffness (x10 ³ kN/m)	6690												
Nominal long term column load (kN)	16600	16500	16500	16400	16400	16300	16300	16200	16200	16100	16000	16000	15900
Equivalent shear stiffness (x10 ³ kN/m)	3.22	3.33	3.46	3.59	3.73	3.87	4.02	4.18	4.34	4.51	4.69	4.87	5.06
Equivalent damping ratio	0.193	0.206	0.219	0.232	0.244	0.255	0.266	0.276	0.285	0.294	0.302	0.310	0.317



Total Rubber Thickness: 20cm

Specification	Shear Modulus (N/mm ²)
	0.385

CHARACTERISTICS	KLRB130R20												
Outer Dia. (mm)	1300												
Lead plug Dia. (mm)	200	210	220	230	240	250	260	270	280	290	300	310	320
Effective area (x 10 ² mm ²)	12959	12927	12893	12858	12821	12782	12742	12701	12657	12613	12566	12518	12469
One rubber layer thickness (mm)	8.7												
Rubber layers No.	23												
Total rubber thickness (mm)	200												
1 st Shape factor	37.4												
2 nd Shape factor	6.50												
Flange Dia. (mm)	1700												
Flange thickness (edge/center)	32/40												
Connecting bolt PCD (mm)	1550												
Connecting bolt hole Dia. x qty	M36 - Ø39 x 12												
Rein. steel plate Thickness (mm)	4.4												
Total height (mm)	376.9												
Total weight (kN) (1kN~100kg)	26.9	26.9	27.0	27.1	27.2	27.3	27.4	27.5	27.6	27.8	27.9	28.0	28.1
Compressive stiffness (x10 ³ kN/m)	7830												
Nominal long term column load (kN)	19400	19400	19300	19300	19200	19200	19100	19100	19000	18900	18800	18800	18700
Equivalent shear stiffness (x10 ³ kN/m)	3.84	3.97	4.10	4.25	4.40	4.56	4.72	4.89	5.07	5.25	5.44	5.63	5.84
Equivalent damping ratio	0.199	0.211	0.223	0.235	0.246	0.256	0.266	0.275	0.284	0.292	0.300	0.307	0.314



Total Rubber Thickness: 20cm

Specification	Shear Modulus (N/mm ²)
	0.385

CHARACTERISTICS	KLRB140R20													
Outer Dia. (mm)	1400													
Lead plug Dia. (mm)	210	220	230	240	250	260	270	280	290	300	310	320	330	340
Effective area (x 10 ² mm ²)	15047	15014	14978	14941	14903	14863	14821	14778	14733	14687	14639	14590	14539	14486
One rubber layer thickness (mm)	9.5													
Rubber layers No.	21													
Total rubber thickness (mm)	200													
1 st Shape factor	36.8													
2 nd Shape factor	7.02													
Flange Dia. (mm)	1800													
Flange thickness (edge/center)	50/100													
Connecting bolt PCD (mm)	1650													
Connecting bolt hole Dia. x qty	M39 - Ø42 x 12													
Rein. steel plate Thickness (mm)	5.8													
Total height (mm)	515.5													
Total weight (kN) (1kN~100kg)	51.1	51.2	51.3	51.4	51.5	51.6	51.8	51.9	52.0	52.1	52.3	52.4	52.5	52.7
Compressive stiffness (x10 ³ kN/m)	9060													
Nominal long term column load (kN)	22600	22500	22500	22400	22400	22300	22200	22200	22100	22000	22000	21900	21800	21700
Equivalent shear stiffness (x10 ³ kN/m)	4.39	4.53	4.67	4.82	4.98	5.14	5.31	5.49	5.67	5.86	6.06	6.26	6.47	6.69
Equivalent damping ratio	0.193	0.205	0.216	0.227	0.237	0.247	0.257	0.266	0.275	0.283	0.291	0.298	0.305	0.311



Total Rubber Thickness: 20cm

Specification	Shear Modulus (N/mm ²)
	0.385

CHARACTERISTICS	KLRB150R20														
Outer Dia. (mm)	1500														
Lead plug Dia. (mm)	230	240	250	260	270	280	290	300	310	320	330	340	350	360	370
Effective area (x 10 ² mm ²)	17256	17219	17181	17141	17099	17056	17011	16965	16917	16867	16816	16764	16709	16654	16596
One rubber layer thickness (mm)	10.0														
Rubber layers No.	20														
Total rubber thickness (mm)	200														
1 st Shape factor	37.5														
2 nd Shape factor	7.5														
Flange Dia. (mm)	1900														
Flange thickness (edge/center)	50/100														
Connecting bolt PCD (mm)	1750														
Connecting bolt hole Dia. x qty	M39 - Ø42 x 12														
Rein. steel plate Thickness (mm)	5.8														
Total height (mm)	510.2														
Total weight (kN) (1kN~100kg)	56.4	56.5	56.6	56.8	56.9	57.0	57.1	57.2	57.4	57.5	57.6	57.8	57.9	58.1	58.2
Compressive stiffness (x10 ³ kN/m)	10400														
Nominal long term column load (kN)	25900	25800	25800	25700	25600	25600	25500	25400	25400	25300	25200	25100	25100	25000	24900
Equivalent shear stiffness (x10 ³ kN/m)	5.10	5.25	5.41	5.57	5.74	5.92	6.10	6.29	6.48	6.69	6.89	7.11	7.33	7.56	7.79
Equivalent damping ratio	0.198	0.209	0.219	0.229	0.239	0.248	0.257	0.266	0.274	0.282	0.289	0.296	0.302	0.309	0.314

