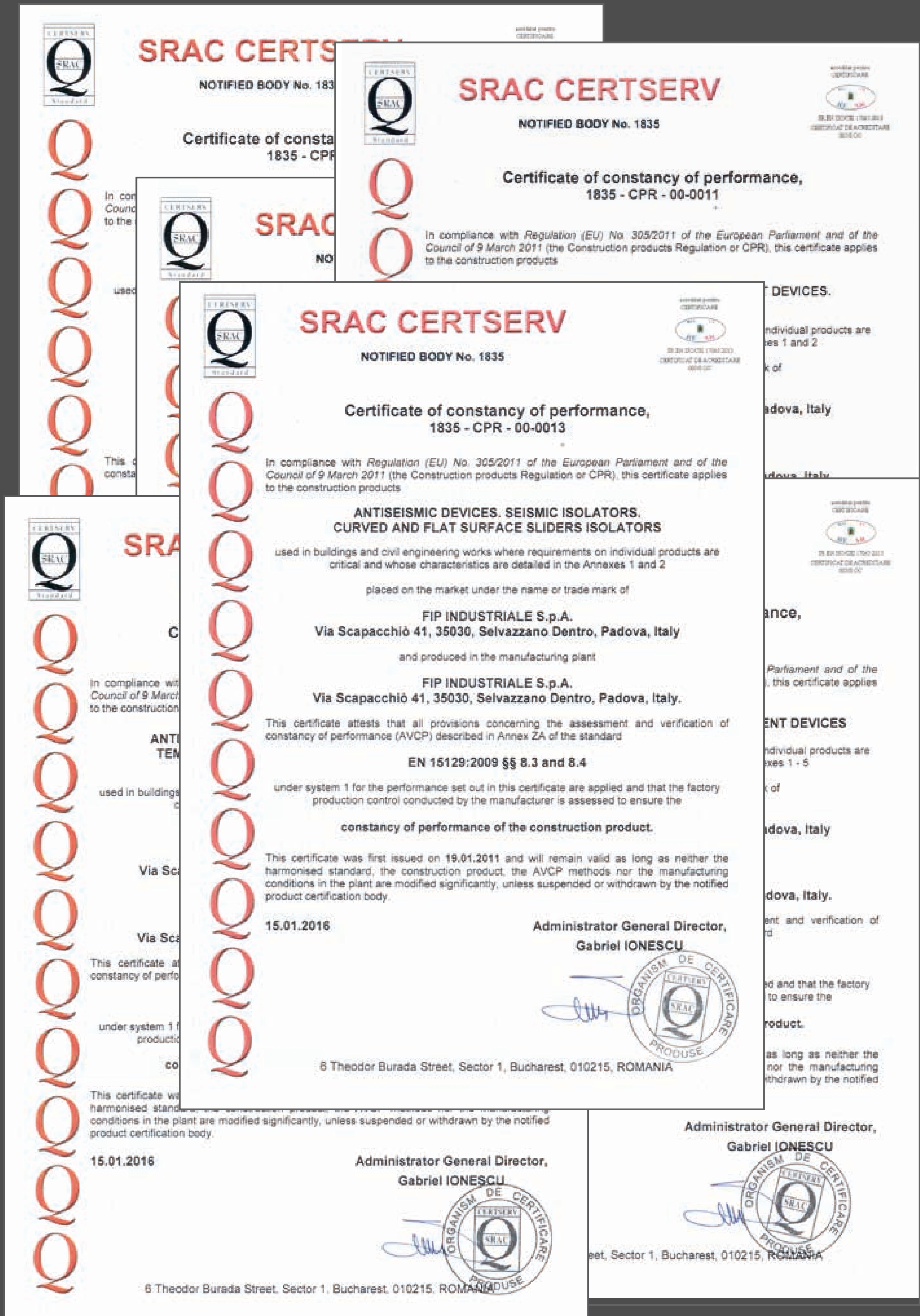
LEAD RUBBER BEARINGS

S03

DEVICES WITH CE MARKING

LEAD RUBBER BEARINGS

FIP INDUSTRIALE
leading technologies



SRAC CERTSERV

NOTIFIED BODY No. 1835

Certificate of constancy of performance,
1835 - CPR - 00-0013

In compliance with *Regulation (EU) No. 305/2011 of the European Parliament and of the Council of 9 March 2011* (the Construction products Regulation or CPR), this certificate applies to the construction products

ANTISEISMIC DEVICES. SEISMIC ISOLATORS.
CURVED AND FLAT SURFACE SLIDERS ISOLATORS

used in buildings and civil engineering works where requirements on individual products are critical and whose characteristics are detailed in the Annexes 1 and 2

placed on the market under the name or trade mark of

FIP INDUSTRIALE S.p.A.
Via Scapacchiò 41, 35030, Selvazzano Dentro, Padova, Italy

and produced in the manufacturing plant

FIP INDUSTRIALE S.p.A.
Via Scapacchiò 41, 35030, Selvazzano Dentro, Padova, Italy.

This certificate attests that all provisions concerning the assessment and verification of constancy of performance (AVCP) described in Annex ZA of the standard

EN 15129:2009 §§ 8.3 and 8.4

under system 1 for the performance set out in this certificate are applied and that the factory production control conducted by the manufacturer is assessed to ensure the

constancy of performance of the construction product.

This certificate was first issued on **19.01.2011** and will remain valid as long as neither the harmonised standard, the construction product, the AVCP methods nor the manufacturing conditions in the plant are modified significantly, unless suspended or withdrawn by the notified product certification body.

15.01.2016

Administrator General Director,
Gabriel IONESCU

6 Theodor Burada Street, Sector 1, Bucharest, 010215, ROMANIA

FIP INDUSTRIALE

INTRODUCTION

CERTIFICATIONS

In 1992, **FIP Industriale** secured CISQ-ICIM certification for its Quality Assurance System in conformance with EN 29001 European Standard (ISO 9001).

FIP Industriale is proud to be the first Italian manufacturer of structural bearings, anti-seismic devices and expansion joints boasting a Quality Assurance System certified at the highest level from design to customer service assistance.

Certification has been achieved via rigorous evaluation by an internationally recognized Third Party Organisation, thus internationally validating the quality assurance system.

In the framework of the enforcement of the European Construction Products Directive, **FIP Industriale** has gained the CE marking of different types of anti-seismic devices, including elastomeric isolators, in accordance with the harmonised European Standard EN 15129:2009 *Anti-seismic devices*.

BIM READY

The use of shared digital representations to facilitate the design, construction and operation of a structure is the starting point for a reliable and interactive decision-making process which allows municipalities, private clients, contractors and designers to rule all their choices.

FIP Industriale is able to provide BIM models – according to IFC standard – to its Clients in such a way to support the communication, cooperation, simulation and improvement of a project through the whole design life of the built or building structure.

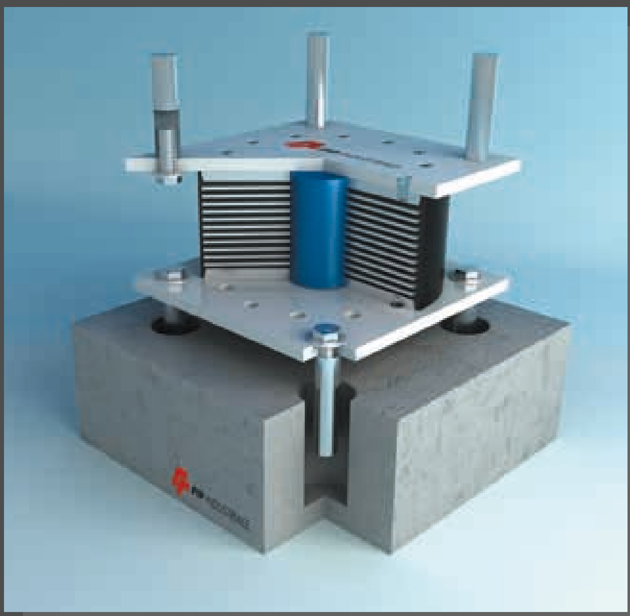
DESCRIPTION

Lead **R**ubber **B**earings (**LRB**) are rubber bearings made up of alternate layers of steel laminates and hot vulcanized rubber with a cilindrical central lead core.

The energy dissipation provided by the lead core, through its yielding, allows to achieve an equivalent viscous damping coefficient up to about 30%, i.e. two times that of high damping elastomeric isolators (SI series).

Thanks to the high energy dissipation capacity, it is possible to reduce the horizontal displacement, in comparison with that of an isolation system with the same equivalent stiffness but lower energy dissipation capacity.

Usually, they are circular in shape but can also be fabricated in square sections; they can also be fabricated with more than one lead core.



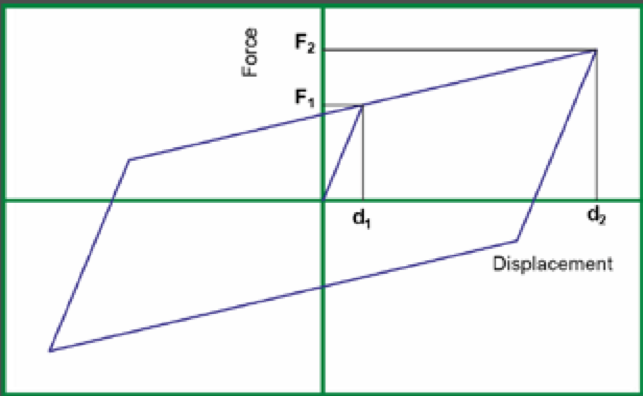
• ANCONA, ITALY - “La Torre” office building

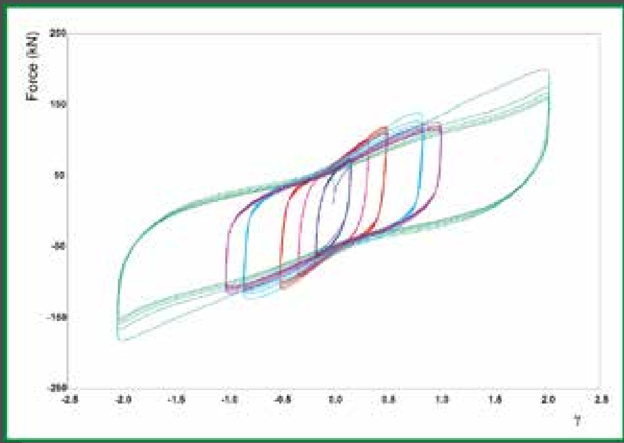
• ANCONA, ITALY - “La Torre” office building: installation

CHARACTERISTICS

MODELING

The typical hysteresis loop of a Lead Rubber Bearing can be modelled as bilinear. The parameters d_1, F_1, d_2, and F_2 that define the bilinear curve are given in the following tables per each standard **LRB**.



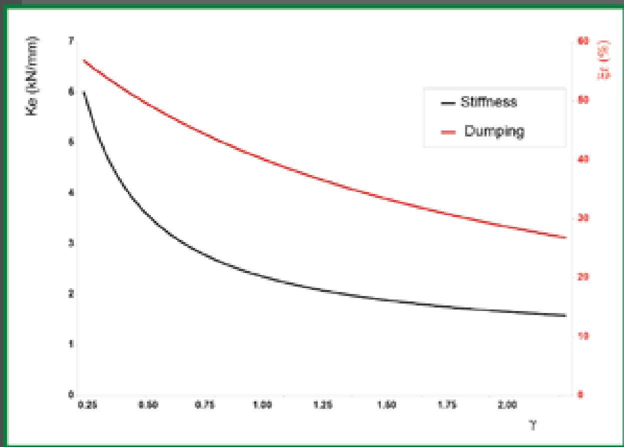


Typical hysteresis loops of a lead rubber bearing obtained with dynamic tests at increasing shear strain amplitude.

The hysteretic behaviour of an **LRB** can also be modelled as linear, by means of the effective stiffness K_e and the equivalent viscous damping coefficient ξ_e, that depend on the maximum displacement d_2 and on the corresponding force F_2 to which they refer:

$$K_e = \frac{F_2}{d_2}$$

$$\xi_e = \frac{2}{\pi} \cdot \left[\frac{F_1}{F_2} - \frac{d_1}{d_2} \right]$$

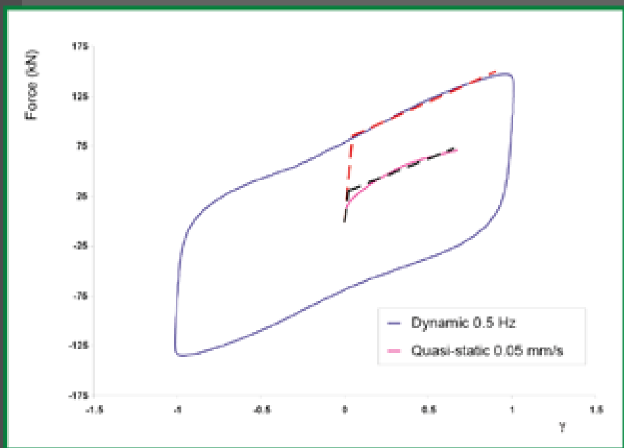


Typical variation of the effective stiffness and of the equivalent viscous damping coefficient as a function of the shear strain.

The K_e and ξ_e values given in the tables refer to the displacement d_2 (maximum design displacement at ULS) but can easily be calculated for different values of the displacement. The graph on the right shows the typical variation of K_e and ξ_e as a function of the shear strain γ of the elastomer (in this case for the isolator LRB-S 800/200-175).

In case of slow movements, due for example to thermal changes, the constitutive behaviour of the isolator is still bilinear, but with different parameters from those corresponding to quick movements, as those induced by the earthquake.

In effects, as it is shown in the graph, the forces developed during slow (quasi-static) movements are much lower than those due to earthquake. In particular, the yield force in quasi-static movements can be assumed equal to about 1/3 of the dynamic force, and the post-elastic stiffness can be assumed equal to about 90% of the dynamic value.



Comparison between the dynamic and quasi-static behavior obtained in tests at different velocity (dynamic test with sinusoidal input at frequency of 0.5 Hz and quasi-static test at velocity of 0.05 mm/s).

MATERIALS

The rubber compounds normally used in the production of **LRB** are characterised by an effective dynamic shear modulus G_{din} equal to 0.4 MPa (S compound) or 0.6 MPa (SN com pound).

Rubber compound with higher values of G_{din} up to 1.4 MPa, may be used on request.

The lead used has high purity, higher than 99.85 %.

DESIGN AND PRODUCTION CRITERIA

STANDARDS

The series **LRB** isolators can be designed *ad hoc* to satisfy all international standards (i.e.: EN 15129, AASHTO, etc.).

Notwithstanding, the standard isolators in this catalogue are designed in compliance with Italian seismic regulations (D.M. dated 14/01/2008) which are based on Eurocode 8 as well as with the European standard EN 1337-3: 2005 (Structural bearings.
Part 3: Elastomeric Bearings) regarding the normal non- seismic service conditions.

DESIGN FEATURES

The standard **LRB** whose geometric and mechanical characteristics are listed in the enclosed tables, are designed for seven different values of maximum displacement, from 100 to 400 mm.

Such entity of displacement is understood to be the maximum design displacement at ULS, factored by the increased reliability factor as per Eurocode 8.

The vertical load V indicated in the tables is the maximum admissible value upon the isolator in the presence of an earthquake provoking the aforesaid displacement.

Null rotation is assumed with reference to the use of these isolators in buildings. The displacement under normal service conditions (i.e. induced by thermal expansion) is assumed to be 10 mm.

FIP Industriale's Technical Department is at the design Engineer's disposal to check standard isolators against displacements and rotations differing from those assumed, and to design *ad hoc* isolators diverging from standard features.

ANCHORING SYSTEMS

The **LRB** are endowed with mechanical anchoring systems providing horizontal load transfer in accordance with Italian and international standards.

QUALITY CONTROL

FIP Industriale's internal quality control system ensures the conformity of the product to the various requirements thus guaranteeing the quality both of materials and manufacturing processes.

QUALIFICATION AND ACCEPTANCE TESTS

FIP Industriale's Test Laboratory is equipped to carry out qualification and acceptance tests on **LRB**.

Series **LRB** isolators have also been tested at independent laboratories.

INSTALLATION

The typical installation procedure of an isolator anchored on its upper and lower side to reinforced cast *in-situ* concrete structures, comprises the following phases:

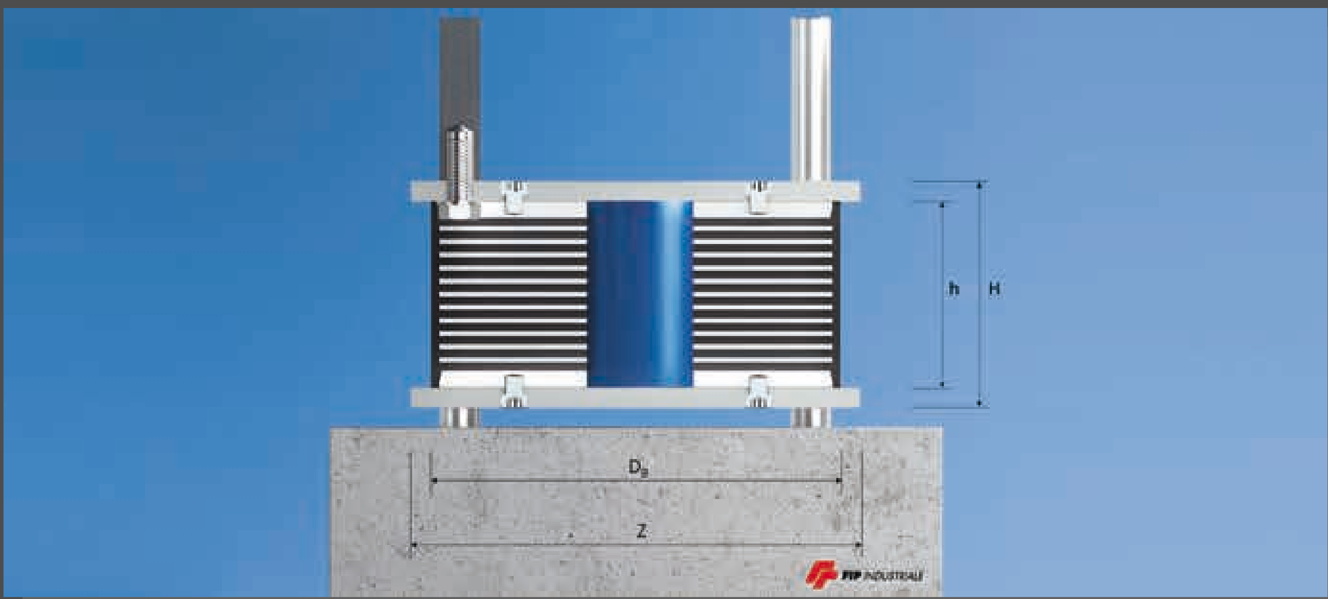
- casting of the substructure up to a level lower than the isolator itself by a few centimeters, leaving holes for the anchor dowels with a diameter at least twice that size;
- positioning of the isolator at the design level and levelling its base horizontally;
- construction of a formwork slightly larger than the isolator and approximately 1 cm higher than its lower edge;
- grouting (with epoxy mortar or non-shrink cementitious mortar) to a suggested thickness between 2 and 5 cm;
- screwing of the upper dowels of the isolator (if not already affixed);
- setting the upper formwork adapting it tightly against the isolator upper plate;
- positioning the superstructure reinforcement followed by concrete casting.

MARKS

The elastomeric isolators with lead core are classified by the mark **LRB** (**L**ead **R**ubber **B**earing) followed by one or more letters (S or SN to indicate the type of compound) and three numbers. The first number represents the external diameter in millimeters, the second stands for the total thickness of the rubber layers in millimeters, and the third represents the diameter of the lead core in millimeters.

Example:

LRB-S 700/203-150 Lead Rubber Bearing, diameter 700 mm, made of rubber compound with G=0.4 MPa, with rubber layers having a total thickness of 203 mm, and a lead core of diameter 150 mm.



BOJANO, ITALY - “G.Lombardo Radice” high school

BOJANO, ITALY - “G.Lombardo Radice” high school: installation

DISPLACEMENT ±100 mm

LRB-S	V	F_{zd}	K_e	ξ_e	F_2	F_1	d_1	K_v	D_g	t_e	h	H	Z
	kN	kN	kN/mm	%	KN	KN	mm	kN/mm	mm	mm	mm	mm	mm
			a d_2 = 83 mm										
LRB-S 500/100-110	2700	3630	1.94	35	162	106	8	1164	500	100	197	247	550
LRB-S 550/100-120	4170	5430	2.33	35	194	126	8	1579	550	100	197	247	600
LRB-S 600/102-120	4830	6500	2.49	33	207	128	8	1715	600	102	190	240	650
LRB-S 650/102-120	6440	9190	2.68	30	223	129	8	2235	650	102	200	260	700
LRB-S 700/105-115	7250	10570	2.74	27	228	121	8	2374	700	105	197	257	750
LRB-S 750/112-125	9240	12530	3.08	28	257	143	9	2754	750	112	207	267	800
LRB-S 800/128-130	10310	13190	3.20	29	267	155	10	2577	800	128	223	283	850
LRB-S 850/128-130	12660	17040	3.40	27	284	157	10	3130	850	128	223	283	900
LRB-S 900/126-140	13490	19250	3.91	28	326	182	10	3359	900	126	228	288	950
LRB-S 1000/135-150	19280	26760	4.50	27	375	210	11	4344	1000	135	251	331	1050
LRB-S 1100/150-160	24050	32410	5.01	27	418	241	12	4725	1100	150	266	346	1150
LRB-S 1200/154-160	29180	38760	5.42	25	452	247	12	5498	1200	154	266	346	1250

LRB-SN	V	F_{zd}	K_e	ξ_e	F_2	F_1	d_1	K_v	D_g	t_e	h	H	Z
	kN	kN	kN/mm	%	KN	KN	mm	kN/mm	mm	mm	mm	mm	mm
			a d_2 = 83 mm										
LRB-SN 500/100-110	4050	6060	2.32	30	193	109	8	1424	500	100	197	247	550
LRB-SN 550/100-120	6260	9060	2.78	29	232	130	8	1892	550	100	197	247	600
LRB-SN 600/102-120	7250	10830	3.02	27	252	132	8	2091	600	102	190	240	650
LRB-SN 650/114-130	9760	13520	3.35	28	279	155	9	2366	650	114	218	278	700
LRB-SN 700/126-140	10540	14260	3.70	29	308	180	10	2339	700	126	227	287	750
LRB-SN 750/126-140	13950	17170	3.97	27	331	182	10	2890	750	126	227	287	800
LRB-SN 800/136-145	15210	18010	4.23	27	352	197	11	2904	800	136	234	294	850
LRB-SN 850/144-155	17420	20410	4.66	28	389	225	12	3267	850	144	245	305	900
LRB-SN 900/144-160	20360	27260	5.10	27	425	241	12	3509	900	144	254	314	950
LRB-SN 1000/153-170	29090	33970	5.85	27	488	275	12	4489	1000	153	277	357	1050
LRB-SN 1100/170-185	33050	37200	6.65	27	554	327	14	4883	1100	170	294	374	1150
LRB-SN 1200/176-185	36490	40620	7.15	25	596	336	14	5651	1200	176	296	376	1250

Legend

V	Maximum vertical load combination including the seimic action (at displacement 1.2 d_2)
F_{zd}	Maximum vertical service load at ULS
K_e	Effective horizontal stiffness (at displacement 1.2 d_2)
ξ_e	Equivalent viscous damping coefficient (at displacement 1.2 d_2)
F_2	Maximum horizontal force (at displacemet 1.2 d_2)
F_1	Yield force
d_1	Yield displacemet
K_v	Vertical stiffness
D_g	External elastomer diameter
t_e	Total elastomer thickness
h	Height excluding outer steel plates
H	Total height including outer steel plates
Z	Side lenght of outer steel plate

LRB-S	V	F_{zd}	K_e	ξ_e	F_2	F_1	d_1	K_v	D_g	t_e	h	H	Z
	kN	kN	kN/mm	%	KN	KN	mm	kN/mm	mm	mm	mm	mm	mm
			a d_2 = 125mm										
LRB-S 500/100-110	2130	3630	1.55	31	193	106	8	1164	500	100	197	247	550
LRB-S 550/100-120	3070	5430	1.86	30	232	126	8	1579	550	100	197	247	600
LRB-S 600/102-120	3630	6500	2.01	28	252	128	8	1715	600	102	190	240	650
LRB-S 650/102-120	4920	9190	2.21	26	276	129	8	2235	650	102	200	260	700
LRB-S 700/105-115	5650	10560	2.30	23	287	121	8	2374	700	105	197	257	750
LRB-S 750/112-125	7350	12530	2.56	24	321	143	9	2754	750	112	207	267	800
LRB-S 800/128-130	8420	13190	2.64	25	331	155	10	2577	800	128	223	283	850
LRB-S 850/128-130	10430	17040	2.85	23	356	157	10	3130	850	128	223	283	900
LRB-S 900/126-140	11160	19250	3.26	23	408	182	10	3359	900	126	228	288	950
LRB-S 1000/135-150	16270	26760	3.76	23	470	210	11	4344	1000	135	251	331	1050
LRB-S 1100/150-160	20680	32410	4.17	23	521	241	12	4725	1100	150	266	346	1150
LRB-S 1200/154-160	25350	38760	4.57	21	572	247	12	5498	1200	154	266	346	1250

LRB-SN	V	F_{zd}	K_e	ξ_e	F_2	F_1	d_1	K_v	D_g	t_e	h	H	Z
	kN	kN	kN/mm	%	KN	KN	mm	kN/mm	mm	mm	mm	mm	mm
			a d_2 = 125mm										
LRB-SN 500/100-110	3200	6060	1.92	25	240	109	8	1424	500	100	197	247	550
LRB-SN 550/100-120	4600	9060	2.31	25	288	130	8	1892	550	100	197	247	600
LRB-SN 600/102-120	5440	10830	2.55	22	318	132	8	2091	600	102	190	240	650
LRB-SN 650/114-130	7580	13520	2.79	24	349	155	9	2366	650	114	218	278	700
LRB-SN 700/126-140	8730	14260	3.05	25	382	180	10	2339	700	126	227	287	750
LRB-SN 750/126-140	11260	17170	3.32	23	415	182	10	2890	750	126	227	287	800
LRB-SN 800/136-145	12650	18010	3.53	23	441	197	11	2904	800	136	234	294	850
LRB-SN 850/144-155	15780	20410	3.87	24	484	225	12	3267	850	144	245	305	900
LRB-SN 900/144-160	17090	27260	4.26	23	532	241	12	3509	900	144	254	314	950
LRB-SN 1000/153-170	24840	33970	4.90	22	612	275	12	4489	1000	153	277	357	1050
LRB-SN 1100/170-185	30780	37200	5.52	23	690	327	14	4883	1100	170	294	374	1150
LRB-SN 1200/176-185	34230	40620	6.02	21	753	336	14	5651	1200	176	296	376	1250

Legend

V	Maximum vertical load combination including the seimic action (at displacement 1.2 d_2)
F_{zd}	Maximum vertical service load at ULS
K_e	Effective horizontal stiffness (at displacement 1.2 d_2)
ξ_e	Equivalent viscous damping coefficient (at displacement 1.2 d_2)
F_2	Maximum horizontal force (at displacemet 1.2 d_2)
F_1	Yield force
d_1	Yield displacemet
K_v	Vertical stiffness
D_g	External elastomer diameter
t_e	Total elastomer thickness
h	Height excluding outer steel plates
H	Total height including outer steel plates
Z	Side lenght of outer steel plate

DISPLACEMENT ±200 mm

LRB-S	V	F_{zd}	K_e	ξ_e	F_2	F_1	d_1	K_v	D_g	t_e	h	H	Z
	kN	kN	kN/mm	%	KN	KN	mm	kN/mm	mm	mm	mm	mm	mm
			a d_2 = 167 mm										
LRB-S 500/100-110	1420	3630	1.35	27	224	106	8	1164	500	100	197	247	550
LRB-S 550/100-120	2120	5430	1.62	27	270	126	8	1579	550	100	197	247	600
LRB-S 600/102-120	2610	6500	1.78	24	296	128	8	1715	600	102	190	240	650
LRB-S 650/102-120	3620	9190	1.97	22	328	129	8	2235	650	102	200	260	700
LRB-S 700/105-115	4250	10570	2.08	19	347	121	8	2374	700	105	197	257	750
LRB-S 750/112-125	5680	12530	2.31	20	385	143	9	2754	750	112	207	267	800
LRB-S 800/128-130	6740	13190	2.37	21	394	155	10	2577	800	128	223	283	850
LRB-S 850/128-130	8420	17040	2.57	19	428	157	10	3130	850	128	223	283	900
LRB-S 900/126-140	9070	19250	2.94	20	490	182	10	3359	900	126	228	288	950
LRB-S 1000/135-150	13510	26760	3.39	20	565	210	11	4344	1000	135	251	331	1050
LRB-S 1100/150-160	17580	32410	3.75	20	625	241	12	4725	1100	150	266	346	1150
LRB-S 1200/154-160	21780	38760	4.15	18	692	247	12	5498	1200	154	266	346	1250

LRB-SN	V	F_{zd}	K_e	ξ_e	F_2	F_1	d_1	K_v	D_g	t_e	h	H	Z
	kN	kN	kN/mm	%	KN	KN	mm	kN/mm	mm	mm	mm	mm	mm
			a d_2 = 167 mm										
LRB-SN 500/100-110	2130	6060	1.72	21	287	109	8	1424	500	100	197	247	550
LRB-SN 550/100-120	3190	9060	2.07	21	345	130	8	1892	550	100	197	247	600
LRB-SN 600/102-120	3910	10830	2.31	19	385	132	8	2091	600	102	190	240	650
LRB-SN 650/114-130	5690	13520	2.51	20	419	155	9	2366	650	114	218	278	700
LRB-SN 700/126-140	6780	14260	2.73	21	455	180	10	2339	700	126	227	287	750
LRB-SN 750/126-140	8870	17170	3.00	19	500	182	10	2890	750	126	227	287	800
LRB-SN 800/136-145	10200	18010	3.19	19	531	197	11	2904	800	136	234	294	850
LRB-SN 850/144-155	12930	20410	3.47	20	579	225	12	3267	850	144	245	305	900
LRB-SN 900/144-160	14120	27260	3.83	20	639	241	12	3509	900	144	254	314	950
LRB-SN 1000/153-170	20940	33970	4.42	19	737	275	12	4489	1000	153	277	357	1050
LRB-SN 1100/170-185	27030	37200	4.95	20	825	327	14	4883	1100	170	294	374	1150
LRB-SN 1200/176-185	31990	40620	5.46	18	910	336	14	5651	1200	176	296	376	1250

Legend

V	Maximum vertical load combination including the seimic action (at displacement 1.2 d_2)
F_{zd}	Maximum vertical service load at ULS
K_e	Effective horizontal stiffness (at displacement 1.2 d_2)
ξ_e	Equivalent viscous damping coefficient (at displacement 1.2 d_2)
F_2	Maximum horizontal force (at displacemet 1.2 d_2)
F_1	Yield force
d_1	Yield displacemet
K_v	Vertical stiffness
D_g	External elastomer diameter
t_e	Total elastomer thickness
h	Height excluding outer steel plates
H	Total height including outer steel plates
Z	Side lenght of outer steel plate

LRB-S	V	F_{zd}	K_e	ξ_e	F_2	F_1	d_1	K_v	D_g	t_e	h	H	Z
	kN	kN	kN/mm	%	KN	KN	mm	kN/mm	mm	mm	mm	mm	mm
			a d_2 = 208mm										
LRB-S 500/125-110	990	2900	1.08	27	224	106	10	932	500	125	237	287	550
LRB-S 550/125-120	1640	4340	1.29	27	270	126	10	1263	550	125	237	287	600
LRB-S 600/126-130	2040	5170	1.52	27	318	148	10	1366	600	126	226	276	650
LRB-S 650/126-140	2870	7230	1.78	26	371	172	10	1761	650	126	236	296	700
LRB-S 700/126-115	3540	8800	1.71	19	357	121	10	1978	700	126	227	287	750
LRB-S 750/126-125	4620	9530	1.98	19	413	143	10	2448	750	126	227	287	800
LRB-S 800/160-155	5730	10300	2.16	26	450	214	13	2010	800	160	267	327	850
LRB-S 850/144-150	6960	14890	2.42	22	504	203	12	2736	850	144	245	305	900
LRB-S 900/135-150	7440	17990	2.72	20	567	206	11	3110	900	135	241	301	950
LRB-S 1000/144-160	11340	26120	3.14	19	654	236	12	4046	1000	144	264	344	1050
LRB-S 1100/170-185	15330	29250	3.53	23	735	312	14	4108	1100	170	294	374	1150
LRB-S 1200/176-185	19320	37000	3.86	21	805	318	14	4751	1200	176	296	376	1250

LRB-SN	V	F_{zd}	K_e	ξ_e	F_2	F_1	d_1	K_v	D_g	t_e	h	H	Z
	kN	kN	kN/mm	%	KN	KN	mm	kN/mm	mm	mm	mm	mm	mm
			a d_2 = 208mm										
LRB-SN 500/125-130	1360	4630	1.55	26	322	148	10	1092	500	125	237	287	550
LRB-SN 550/125-120	2470	7240	1.66	21	345	130	10	1514	550	125	237	287	600
LRB-SN 600/126-120	3130	8760	1.86	19	388	132	10	1693	600	126	226	276	650
LRB-SN 650/138-130	4650	11170	2.05	20	428	155	11	1955	650	138	254	314	700
LRB-SN 700/140-140	5430	12830	2.36	20	492	180	11	2105	700	140	247	307	750
LRB-SN 750/140-140	7240	15900	2.60	18	542	182	11	2601	750	140	247	307	800
LRB-SN 800/144-155	8170	17920	2.97	19	618	222	12	2716	800	144	245	305	850
LRB-SN 850/160-170	10730	20250	3.19	21	664	265	13	2902	850	160	267	327	900
LRB-SN 900/171-185	12040	22940	3.49	23	728	312	14	2892	900	171	293	353	950
LRB-SN 1000/180-200	18100	33560	4.10	23	853	366	15	3737	1000	180	316	396	1050
LRB-SN 1100/190-200	23710	37010	4.49	21	934	374	15	4330	1100	190	322	402	1150
LRB-SN 1200/209-215	29400	40260	4.97	22	1036	434	17	4685	1200	209	341	421	1250

Legend

V	Maximum vertical load combination including the seimic action (at displacement 1.2 d_2)
F_{zd}	Maximum vertical service load at ULS
K_e	Effective horizontal stiffness (at displacement 1.2 d_2)
ξ_e	Equivalent viscous damping coefficient (at displacement 1.2 d_2)
F_2	Maximum horizontal force (at displacemet 1.2 d_2)
F_1	Yield force
d_1	Yield displacemet
K_v	Vertical stiffness
D_g	External elastomer diameter
t_e	Total elastomer thickness
h	Height excluding outer steel plates
H	Total height including outer steel plates
Z	Side lenght of outer steel plate

LRB-S	V	F_{zd}	K_e	ξ_e	F_2	F_1	d_1	K_v	D_g	t_e	h	H	Z
	kN	kN	kN/mm	%	KN	KN	mm	kN/mm	mm	mm	mm	mm	mm
			a d_2 = 250 mm										
LRB-S 500/150-110	540	2420	0.90	27	224	106	12	776	500	150	277	327	550
LRB-S 550/150-120	1050	3620	1.08	27	270	126	12	1052	550	150	277	327	600
LRB-S 600/150-130	1500	4350	1.28	26	319	148	12	1148	600	150	262	312	650
LRB-S 650/150-140	2290	6070	1.49	26	373	172	12	1479	650	150	272	332	700
LRB-S 700/154-150	2780	6900	1.70	26	424	197	12	1550	700	154	267	327	750
LRB-S 750/154-160	3750	9200	1.94	26	485	225	12	1926	750	154	267	327	800
LRB-S 800/168-155	4630	9800	1.94	25	486	214	14	1915	800	168	278	338	850
LRB-S 850/168-150	5990	12760	2.05	22	513	203	14	2345	850	168	278	338	900
LRB-S 900/162-150	6610	15000	2.27	20	567	206	13	2592	900	162	280	340	950
LRB-S 1000/171-160	10200	21990	2.63	19	659	236	14	3407	1000	171	303	383	1050
LRB-S 1100/170-185	12870	29250	3.30	21	825	312	14	4108	1100	170	294	374	1150
LRB-S 1200/176-185	16470	37000	3.64	19	910	318	14	4751	1200	176	296	376	1250

LRB-SN	V	F_{zd}	K_e	ξ_e	F_2	F_1	d_1	K_v	D_g	t_e	h	H	Z
	kN	kN	kN/mm	%	KN	KN	mm	kN/mm	mm	mm	mm	mm	mm
			a d_2 = 250 mm										
LRB-SN 500/150-130	710	3860	1.29	26	322	148	12	910	500	150	277	327	550
LRB-SN 550/150-145	1400	5740	1.58	27	394	184	12	1205	550	150	277	327	600
LRB-SN 600/150-150	2100	6990	1.80	25	451	198	12	1355	600	150	262	312	650
LRB-SN 650/150-170	3130	9630	2.19	26	547	253	12	1697	650	150	272	332	700
LRB-SN 700/154-160	4080	11350	2.27	23	566	229	12	1865	700	154	267	327	750
LRB-SN 750/154-170	5510	15130	2.59	22	647	259	12	2288	750	154	267	327	800
LRB-SN 800/168-155	6940	16340	2.52	19	630	222	14	2328	800	168	278	338	850
LRB-SN 850/168-170	8780	19600	2.90	20	725	265	14	2764	850	168	278	338	900
LRB-SN 900/171-185	9780	22940	3.27	21	817	312	14	2892	900	171	293	353	950
LRB-SN 1000/180-200	15080	33560	3.83	21	958	366	15	3737	1000	180	316	396	1050
LRB-SN 1100/190-200	20150	37010	4.22	19	1055	374	15	4330	1100	190	322	402	1150
LRB-SN 1200/209-215	26140	40260	4.67	19	1167	434	17	4685	1200	209	341	421	1250

Legend

V	Maximum vertical load combination including the seimic action (at displacement 1.2 d_2)
F_{zd}	Maximum vertical service load at ULS
K_e	Effective horizontal stiffness (at displacement 1.2 d_2)
ξ_e	Equivalent viscous damping coefficient (at displacement 1.2 d_2)
F_2	Maximum horizontal force (at displacemet 1.2 d_2)
F_1	Yield force
d_1	Yield displacemet
K_v	Vertical stiffness
D_g	External elastomer diameter
t_e	Total elastomer thickness
h	Height excluding outer steel plates
H	Total height including outer steel plates
Z	Side lenght of outer steel plate

LRB-S	V	F_{zd}	K_e	ξ_e	F_2	F_1	d_1	K_v	D_g	t_e	h	H	Z
	kN	kN	kN/mm	%	KN	KN	mm	kN/mm	mm	mm	mm	mm	mm
			a d_2 = 292mm										
LRB-S 500/175-110	240	2070	0.77	27	224	106	14	665	500	175	317	367	550
LRB-S 550/175-120	580	3100	0.92	27	270	126	14	902	550	175	317	367	600
LRB-S 600/180-130	900	3620	1.08	27	314	148	15	956	600	180	307	357	650
LRB-S 650/180-140	1530	5060	1.26	27	367	172	15	1232	650	180	317	377	700
LRB-S 700/175-150	2120	6080	1.48	26	430	197	14	1364	700	175	297	357	750
LRB-S 750/175-160	3030	8100	1.69	26	492	225	14	1695	750	175	297	357	800
LRB-S 800/176-175	3530	9150	1.95	27	570	268	14	1785	800	176	289	349	850
LRB-S 850/176-185	4870	11810	2.20	27	641	300	14	2160	850	176	289	349	900
LRB-S 900/180-195	5270	12940	2.42	27	707	333	15	2235	900	180	306	366	950
LRB-S 1000/180-200	8230	20250	2.81	24	819	354	15	3140	1000	180	316	396	1050
LRB-S 1100/190-200	11270	25900	3.07	22	894	360	15	3639	1100	190	322	402	1150
LRB-S 1200/187-200	14230	34520	3.48	20	1016	365	15	4435	1200	187	311	391	1250

LRB-SN	V	F_{zd}	K_e	ξ_e	F_2	F_1	d_1	K_v	D_g	t_e	h	H	Z
	kN	kN	kN/mm	%	KN	KN	mm	kN/mm	mm	mm	mm	mm	mm
			a d_2 = 292mm										
LRB-SN 500/175-130	290	3310	1.11	26	322	148	14	780	500	175	317	367	550
LRB-SN 550/175-145	730	4920	1.35	27	394	184	14	1033	550	175	317	367	600
LRB-SN 600/180-150	1230	5830	1.52	25	443	198	15	1129	600	180	307	357	650
LRB-SN 650/180-170	2050	8020	1.85	27	539	253	15	1414	650	180	317	377	700
LRB-SN 700/175-170	3010	9830	2.06	24	600	256	14	1618	700	175	297	357	750
LRB-SN 750/175-170	4450	13320	2.25	22	657	259	14	2013	750	175	297	357	800
LRB-SN 800/176-190	5130	14950	2.64	23	769	321	14	2137	800	176	289	349	850
LRB-SN 850/176-185	6900	19600	2.81	21	820	308	14	2600	850	176	289	349	900
LRB-SN 900/198-185	8500	19810	2.81	21	821	312	16	2498	900	198	332	392	950
LRB-SN 1000/180-200	12340	33560	3.64	19	1063	366	15	3737	1000	180	316	396	1050
LRB-SN 1100/220-200	18250	37010	3.64	19	1061	374	18	3740	1100	220	364	444	1150
LRB-SN 1200/242-215	23970	40260	4.02	19	1173	434	20	4046	1200	242	386	466	1250

Legend

V	Maximum vertical load combination including the seimic action (at displacement 1.2 d_2)
F_{zd}	Maximum vertical service load at ULS
K_e	Effective horizontal stiffness (at displacement 1.2 d_2)
ξ_e	Equivalent viscous damping coefficient (at displacement 1.2 d_2)
F_2	Maximum horizontal force (at displacemet 1.2 d_2)
F_1	Yield force
d_1	Yield displacemet
K_v	Vertical stiffness
D_g	External elastomer diameter
t_e	Total elastomer thickness
h	Height excluding outer steel plates
H	Total height including outer steel plates
Z	Side lenght of outer steel plate

DISPLACEMENT ±400 mm

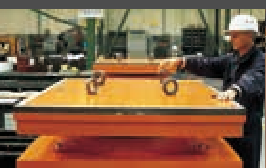
LRB-S	V	F_{zd}	K_e	ξ_e	F_2	F_1	d_1	K_v	D_g	t_e	h	H	Z
	kN	kN	kN/mm	%	KN	KN	mm	kN/mm	mm	mm	mm	mm	mm
			a d_2 = 333 mm										
LRB-S 500/200-110	50	1810	0.67	27	224	106	16	582	500	200	357	407	550
LRB-S 550/200-120	260	2710	0.81	27	270	126	16	789	550	200	357	407	600
LRB-S 600/204-130	500	3190	0.95	27	315	148	16	844	600	204	343	393	650
LRB-S 650/204-140	960	4460	1.11	27	368	172	16	1087	650	204	353	413	700
LRB-S 700/203-150	1390	5240	1.28	26	427	197	16	1176	700	203	337	397	750
LRB-S 750/203-160	2170	6980	1.46	26	488	225	16	1461	750	203	337	397	800
LRB-S 800/200-175	2810	8050	1.71	27	572	268	16	1571	800	200	322	382	850
LRB-S 850/200-185	3850	10350	1.93	27	643	300	16	1901	850	200	322	382	900
LRB-S 900/207-195	4540	11250	2.11	27	704	333	17	1943	900	207	345	405	950
LRB-S 1000/207-200	7290	17610	2.45	24	816	354	17	2731	1000	207	355	435	1050
LRB-S 1100/220-200	10230	22370	2.66	22	887	360	18	3143	1100	220	364	444	1150
LRB-S 1200/220-200	13240	29340	2.99	20	996	365	18	3770	1200	220	356	436	1250

LRB-SN	V	F_{zd}	K_e	ξ_e	F_2	F_1	d_1	K_v	D_g	t_e	h	H	Z
	kN	kN	kN/mm	%	KN	KN	mm	kN/mm	mm	mm	mm	mm	mm
			a d_2 = 333 mm										
LRB-SN 500/200-130	10	2890	0.97	26	322	148	16	683	500	200	357	407	550
LRB-SN 550/200-145	280	4300	1.18	27	394	184	16	904	550	200	357	407	600
LRB-SN 600/204-150	660	5140	1.34	25	445	198	16	996	600	204	343	393	650
LRB-SN 650/204-170	1240	7080	1.62	27	541	253	16	1248	650	204	353	413	700
LRB-SN 700/203-170	1940	8480	1.79	24	595	256	16	1395	700	203	337	397	750
LRB-SN 750/203-170	3170	11480	1.95	22	651	259	16	1736	750	203	337	397	800
LRB-SN 800/200-190	4070	13160	2.32	23	772	321	16	1881	800	200	322	382	850
LRB-SN 850/200-185	5780	16910	2.47	21	823	308	16	2288	850	200	322	382	900
LRB-SN 900/225-185	6630	17430	2.47	21	824	312	18	2198	900	225	371	431	950
LRB-SN 1000/207-200	10940	29350	3.18	19	1058	366	17	3249	1000	207	355	435	1050
LRB-SN 1100/250-200	15630	32810	3.19	19	1065	374	20	3291	1100	250	406	486	1150
LRB-SN 1200/275-215	19840	38760	3.53	19	1177	434	22	3560	1200	275	431	511	1250

Legend

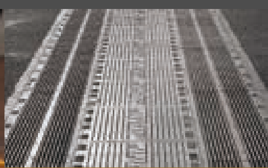
V	Maximum vertical load combination including the seimic action (at displacement 1.2 d_2)
F_{zd}	Maximum vertical service load at ULS
K_e	Effective horizontal stiffness (at displacement 1.2 d_2)
ξ_e	Equivalent viscous damping coefficient (at displacement 1.2 d_2)
F_2	Maximum horizontal force (at displacemet 1.2 d_2)
F_1	Yield force
d_1	Yield displacemet
K_v	Vertical stiffness
D_g	External elastomer diameter
t_e	Total elastomer thickness
h	Height excluding outer steel plates
H	Total height including outer steel plates
Z	Side lenght of outer steel plate

DEC 2016

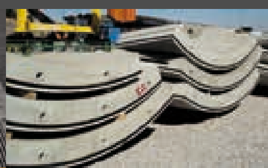


BRIDGE BEARINGS

ANTI-SEISMIC DEVICES



EXPANSION JOINTS



FITTINGS FOR TUNNEL

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