



Seismic protection

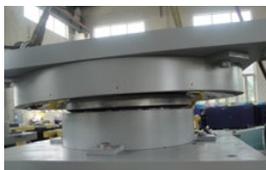
mageba seismic protection devices – for reliable preservation of structures



PENDULUM PM (Mono)

RESTON® PENDULUM Curved Surface Slider

safe, innovative, versatile



mageba
Switzerland www.mageba.ch



Characteristics & types

Principle

mageba RESTON®PENDULUM curved surface sliders are based on the working principle of a pendulum. They allow the horizontal displacement of structure, providing the required shift in the natural period of the structure. Once activated by an earthquake, the isolators will allow the decoupling of the supported structure from the ground motion. After the seismic event, the restoring force due to gravity will bring it back towards the centre position. The performance of the device mainly depends on its radius of curvature and the coefficient of friction.

Properties

RESTON®PENDULUM curved surface sliders reliably serve the following main functions:

- Under service conditions, the devices are designed to transmit vertical forces and allow for horizontal displacements
- In case of an earthquake, lateral flexibility is achieved through the sliding of an element along the primary curved surface
- Energy dissipation is produced by the dynamic friction between the sliding stainless steel surface and the ROBO®SLIDE high performance sliding material
- Finally, the re-centring function is given by the combination of gravity and geometry of the device's design

Seismic isolation

Seismic isolation is the decoupling of structures from ground motions induced by earthquake motions which could cause damage to the structure. To achieve such decoupling, specific seismic devices – known as isolators – are strategically installed in specific locations of structures, allowing the latter to perform properly during an earthquake.

Seismic isolators such as the RESTON®PENDULUM curved surface sliders provide the structure with sufficient flexibility so that the natural period of the structure differentiates as much as possible from the natural period of the earthquake. This prevents the occurrence of resonance, which could lead to severe damage or even collapse of a structure.

Types

RESTON®PENDULUM Mono (PM)

mageba RESTON®PENDULUM Mono consist of three basic elements: A primary curved sliding surface, whose radius of curvature determines the oscillation period of the device, a steel element equipped with ROBO®SLIDE which slides along the primary curved surface, and a steel plate especially designed to allow the rotations of the devices. The size of the primary sliding surface depends on the required maximum design displacement.

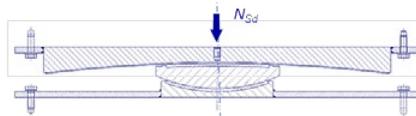
RESTON®PENDULUM Duplo (PD)

mageba RESTON®PENDULUM Duplo includes two primary curved sliding surfaces. This allows higher horizontal displacements to be facilitated with smaller dimensions. The Duplo type includes a rocking element equipped with an articulation element that allows the bearing to accommodate rotations. This is an essential feature, especially for use with bridges which require high displacements and significant rotational capacity.

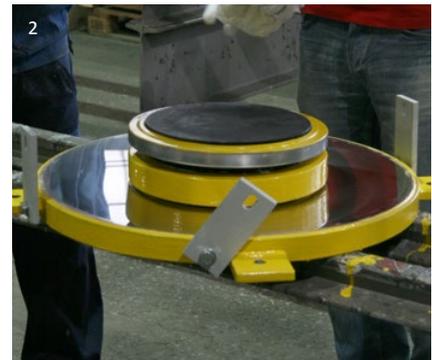
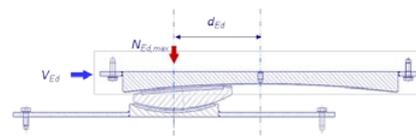
The drawings below compare the sizes between RESTON®PENDULUM Mono and Duplo curved surface sliders. The dynamic requirements for both types are identical.



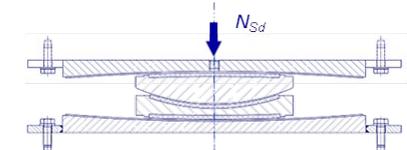
1 a) Service condition



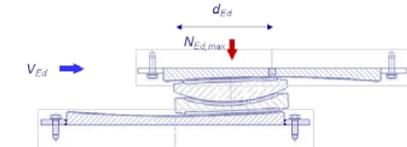
1 b) Seismic condition



2 a) Service condition



2 b) Seismic condition



- 1 Articulated rocking element of RESTON®PENDULUM Mono (PM) to provide high rotation capacity
- 2 RESTON®PENDULUM (Duplo) PD

Properties & benefits

Materials

The following materials are used by mageba for the production of the RESTON®PENDULUM curved surface sliders:

- Steel parts made from S355
- Certified ROBO®SLIDE sliding material with and without grease dimples in accordance with European Technical Approval ETA-08/0115
- Certified silicone grease as lubricant
- Coating of calotte with hard chrome
- Sliding plate from polished austenitic stainless steel (grade 1.4401)

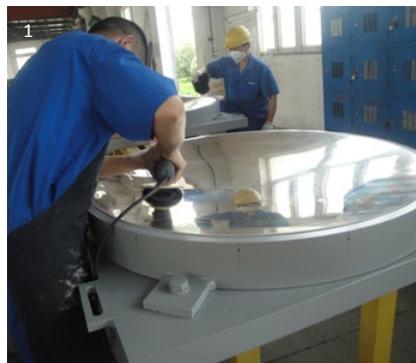
Main Dimensions

The table below provides the main dimensions of the RESTON®PENDULUM Mono and Duplo curved surface sliders in function of the vertical load and the maximum design displacement.

Corrosion protection

mageba proposes standard corrosion protection systems according to EN ISO 12944, with corrosivity category depending on location, environmental conditions and the required degree of protection.

Corrosion protection systems according to other standards can be provided upon request.



1 Surface treatment of RESTON®PENDULUM

Benefits

- Reduction of the dynamic impact on structural elements allowing slender as well as economical structures
- Significant increase of the seismic safety of the structure and its users
- High load bearing capabilities with compact geometry
- Re-centring capabilities allowing the structure to return to the initial position after excessive displacements
- Simplicity in design and adaptability to any type of structure
- Applicable for new structures as well as for retrofitting of existing ones
- Longer life of the devices due to highest quality standards for all components
- Virtually maintenance free due to high durability of the corrosion protection and high performance sliding material
- Proven seismic protection technology throughout the years in structures all over the world

PENDULUM PM (Mono)						PENDULUM PD (Duplo)					
Type	Vertical load N_{Sd} [kN]	Sliding plate diameter (mm)				Type	Vertical load N_{Sd} [kN]	Sliding plate diameter (mm)			
		dbd = ±100	dbd = ±200	dbd = ±300	dbd = ±400			dbd = ±100	dbd = ±200	dbd = ±300	dbd = ±400
PM-2	2,000	460	660	860	1,060	PD-2	2,000	317	455	593	731
PM-3	3,000	505	705	905	1,105	PD-3	3,000	348	486	624	762
PM-4	4,000	550	750	950	1,150	PD-4	4,000	379	517	655	793
PM-5	5,000	590	790	990	1,190	PD-5	5,000	407	545	683	821
PM-6	6,000	635	835	1,035	1,235	PD-6	6,000	438	576	714	852
PM-7	7,000	690	890	1,090	1,290	PD-7	7,000	476	614	752	890
PM-8	8,000	735	935	1,135	1,335	PD-8	8,000	507	645	783	921
PM-9	9,000	780	980	1,180	1,380	PD-9	9,000	538	676	814	952
PM-10	10,000	825	1,025	1,225	1,425	PD-10	10,000	569	707	845	983
PM-11	11,000	860	1,060	1,260	1,460	PD-11	11,000	593	731	869	1,007
PM-12	12,000	900	1,100	1,300	1,500	PD-12	12,000	621	759	897	1,034
PM-15	15,000	990	1,190	1,390	1,590	PD-15	15,000	683	821	959	1,097
PM-20	20,000	1,125	1,325	1,525	1,725	PD-20	20,000	776	914	1,052	1,190
PM-25	25,000	1,250	1,450	1,650	1,850	PD-25	25,000	862	1,000	1,138	1,276
PM-30	30,000	1,340	1,540	1,740	1,940	PD-30	30,000	924	1,062	1,200	1,338
PM-35	35,000	1,500	1,700	1,900	2,100	PD-35	35,000	1,034	1,172	1,310	1,448
PM-40	40,000	1,650	1,850	2,050	2,250	PD-40	40,000	1,138	1,276	1,414	1,552
PM-45	45,000	1,760	1,960	2,160	2,360	PD-45	45,000	1,214	1,352	1,490	1,628

dbd: maximum design displacement. The values in the above table are based on radius of curvature of 3.6m for Mono isolators, and 7.1m for Duplo isolators.

Important Note: This table is intended to be used only as a preliminary reference for the design of the isolator. The final design and technical details will be fully defined once all the parameters of the project, such as natural period and seismic conditions, are considered in the final design.



Quality & support

Quality

For five decades, mageba bearings have proven their worth in thousands of structures under most demanding conditions. In addition to the product properties, the extensive experience of mageba's well-qualified manufacturing and installation staff also contributes to the high quality and durability of the products.

mageba has a process-orientated quality system that is certified in accordance with ISO 9001:2008. mageba's factories are certified for welding in accordance with ISO 3834-2, and according to the current steel construction standard EN 1090.

CE Certification

RESTON®PENDULUM bearings are designed and manufactured in accordance with European Standard EN 15129:2009 and with EN 1337. Bearings are marked with the CE mark of conformity, which confirms that they satisfy all requirements of this standard, without exception. All necessary type testing performed on RESTON®PENDULUM bearings were carried out at an independent testing facility, fully supervised by a certified body.

Testing

If required by the client, a full-scale factory production control testing can be carried out. mageba performs the tests in-house as well as with independent 3rd party test institutes. Commonly performed tests are based on European Standard EN 15129:2009.

Combination

Where required by the project specifications, RESTON®PENDULUM curved surface sliders can be combined with other mageba seismic devices such as RESTON®SA Shock Absorbers, RESTON®STU Shock Transmission Units and RESTON®PSD Preloaded Spring Dampers.

mageba provides the necessary consulting for the most effective and suitable seismic isolation and damping solution.

Installation

mageba offers installation supervision for its products all over the world. The supervision is highly recommended to ensure a proper installation of the devices and to profit of the full mageba guarantee.

Careful handling of the devices is essential during transportation and installation to avoid damages.

Inspection and maintenance

Thanks to the use of high quality components, the application of advanced design methods and a systematic internal quality assurance system, mageba seismic devices can be regarded as maintenance free.

Nevertheless, mageba recommends a visual inspection to be carried out every 3–5 years.

Upon delivery of the units, mageba submits an installation as well as an inspection and maintenance manual, allowing a regular and appropriate inspection to be carried out by the operations and maintenance staff.

Customer support

Our product specialists will be pleased to advise you in the selection of the optimal solution for your project, and to provide you with a quotation.

On our website, www.mageba.ch, you will find further product information, including reference lists and tender documentation.

Reference projects for mageba seismic devices



Awaza Bridge (TM)



Flendruz (CH)



Langenargen (DE)



Ramstore Bridge (KZ)



Agin Bridge (TR)



Vasco da Gama Bridge (PT)

mageba seismic protection devices



RESTON®SA & STU



RESTON®PSD



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