



Seismic devices

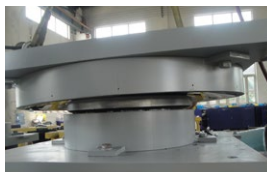
mageba seismic protection devices – for reliable preservation of structures



PENDULUM PM (Mono)

RESTON® PENDULUM Curved Surface Slider

safe, innovative, versatile



mageba



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 center 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-centering 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.

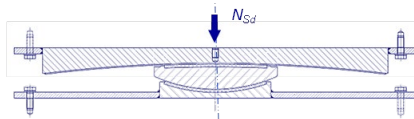
RESTON®PENDULUM Duplo (PD)

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 sliding element equipped with an articulation element that allows the bearing to accommodate rotations. This is an essential feature, especially for use in bridges which require high displacements and significant rotational capacity.

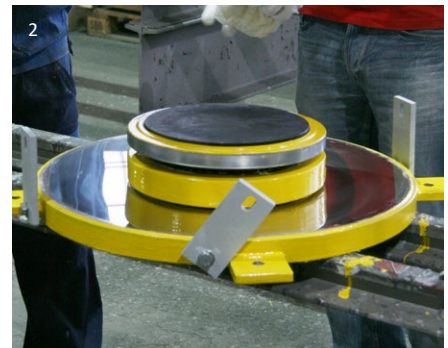
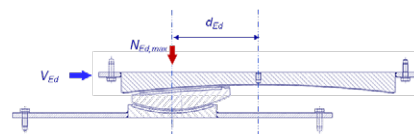
The drawings below compare the sizes between RESTON®PENDULUM Mono and Duplo curved surface sliders. The dynamic requirements for both types are identical.



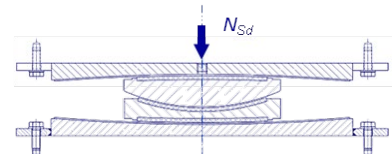
1 a) Service condition



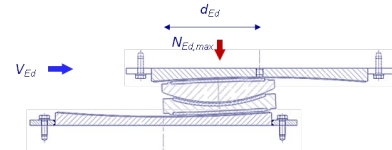
1 b) Seismic condition



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 ASTM A709 Grade 36 or Grade 50
- Certified ROBO®SLIDE sliding material with and without grease dimples in accordance with European Technical Approval ETA-08/0115
- Certified silicone grease as lubricant
- Mating surfaces of backing plates with hard chromium plating or made of polished austenitic stainless steel as per ASTM A480/A480M

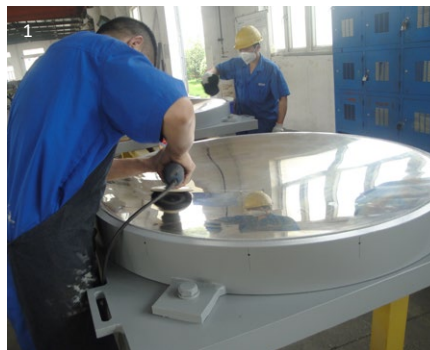
Main Dimensions

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 corrosion protection systems based on hot dip galvanizing ASTM A-123 / AASTHO M111, or any applicable painting systems approved by the responsible Department of Transportation (D.O.T.).

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-centering 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 | | Sliding plate diameter inches / mm | | | | | | | Type | Vertical load | | Sliding plate diameter inches / mm | | | | | | | | |
| | N _{sd} [kips] | N _{sd} [kN] | dbd = ±3.9 | dbd = ±100 | dbd = ±7.9 | dbd = ±200 | dbd = ±11.8 | dbd = ±300 | dbd = ±15.7 | | dbd = ±400 | N _{sd} [kips] | N _{sd} [kN] | dbd = ±3.9 | dbd = ±100 | dbd = ±7.9 | dbd = ±200 | dbd = ±11.8 | dbd = ±300 | dbd = ±15.7 | dbd = ±400 |
| PM-2 | 449.6 | 2,000 | 18.1 | 460 | 26.0 | 660 | 33.9 | 860 | 41.7 | 1,060 | PD-2 | 449.6 | 2,000 | 12.5 | 317 | 17.9 | 455 | 23.3 | 593 | 28.8 | 731 |
| PM-3 | 674.4 | 3,000 | 19.9 | 505 | 27.8 | 705 | 35.6 | 905 | 43.5 | 1,105 | PD-3 | 674.4 | 3,000 | 13.7 | 348 | 19.1 | 486 | 24.6 | 624 | 30 | 762 |
| PM-4 | 899.2 | 4,000 | 21.7 | 550 | 29.5 | 750 | 37.4 | 950 | 45.3 | 1,150 | PD-4 | 899.2 | 4,000 | 14.9 | 379 | 20.4 | 517 | 25.8 | 655 | 31.2 | 793 |
| PM-5 | 1,124 | 5,000 | 23.2 | 590 | 31.1 | 790 | 39.0 | 990 | 46.9 | 1,190 | PD-5 | 1,124 | 5,000 | 16.0 | 407 | 21.5 | 545 | 26.9 | 683 | 32.3 | 821 |
| PM-6 | 1,349 | 6,000 | 25.0 | 635 | 32.9 | 835 | 40.7 | 1,035 | 48.6 | 1,235 | PD-6 | 1,349 | 6,000 | 17.2 | 438 | 22.7 | 576 | 28.1 | 714 | 33.5 | 852 |
| PM-7 | 1,574 | 7,000 | 27.2 | 690 | 35.0 | 890 | 42.9 | 1,090 | 50.8 | 1,290 | PD-7 | 1,574 | 7,000 | 18.7 | 476 | 24.2 | 614 | 29.6 | 752 | 35.0 | 890 |
| PM-8 | 1,799 | 8,000 | 28.9 | 735 | 36.8 | 935 | 44.7 | 1,135 | 52.6 | 1,335 | PD-8 | 1,799 | 8,000 | 20.0 | 507 | 25.4 | 645 | 30.8 | 783 | 36.3 | 921 |
| PM-9 | 2,023 | 9,000 | 30.7 | 780 | 38.6 | 980 | 46.5 | 1,180 | 54.3 | 1,380 | PD-9 | 2,023 | 9,000 | 21.2 | 538 | 26.6 | 676 | 32.0 | 814 | 37.5 | 952 |
| PM-10 | 2,248 | 10,000 | 32.5 | 825 | 40.4 | 1,025 | 48.2 | 1,225 | 56.1 | 1,425 | PD-10 | 2,248 | 10,000 | 22.4 | 569 | 27.8 | 707 | 33.3 | 845 | 38.7 | 983 |
| PM-11 | 2,473 | 11,000 | 33.9 | 860 | 41.7 | 1,060 | 49.6 | 1,260 | 57.5 | 1,460 | PD-11 | 2,473 | 11,000 | 23.3 | 593 | 28.8 | 731 | 34.2 | 869 | 39.6 | 1,007 |
| PM-12 | 2,698 | 12,000 | 35.4 | 900 | 43.3 | 1,100 | 51.2 | 1,300 | 59.1 | 1,500 | PD-12 | 2,698 | 12,000 | 24.4 | 621 | 29.9 | 759 | 35.3 | 897 | 40.7 | 1,034 |
| PM-15 | 3,372 | 15,000 | 39.0 | 990 | 46.9 | 1,190 | 54.7 | 1,390 | 62.6 | 1,590 | PD-15 | 3,372 | 15,000 | 26.9 | 683 | 32.3 | 821 | 37.8 | 959 | 43.2 | 1,097 |
| PM-20 | 4,496 | 20,000 | 44.3 | 1,125 | 52.2 | 1,325 | 60.0 | 1,525 | 67.9 | 1,725 | PD-20 | 4,496 | 20,000 | 30.6 | 776 | 36.0 | 914 | 41.4 | 1,052 | 46.9 | 1,190 |
| PM-25 | 5,620 | 25,000 | 49.2 | 1,250 | 57.1 | 1,450 | 65.0 | 1,650 | 72.8 | 1,850 | PD-25 | 5,620 | 25,000 | 33.9 | 862 | 39.4 | 1,000 | 44.8 | 1,138 | 50.2 | 1,276 |
| PM-30 | 6,744 | 30,000 | 52.8 | 1,340 | 60.6 | 1,540 | 68.5 | 1,740 | 76.4 | 1,940 | PD-30 | 6,744 | 30,000 | 36.4 | 924 | 41.8 | 1,062 | 47.2 | 1,200 | 52.7 | 1,338 |
| PM-35 | 7,868 | 35,000 | 59.1 | 1,500 | 66.9 | 1,700 | 74.8 | 1,900 | 82.7 | 2,100 | PD-35 | 7,868 | 35,000 | 40.7 | 1,034 | 46.1 | 1,172 | 51.6 | 1,310 | 57.0 | 1,448 |
| PM-40 | 8,992 | 40,000 | 65.0 | 1,650 | 72.8 | 1,850 | 80.7 | 2,050 | 88.6 | 2,250 | PD-40 | 8,992 | 40,000 | 44.8 | 1,138 | 50.2 | 1,276 | 55.7 | 1,414 | 61.1 | 1,552 |
| PM-45 | 10,116 | 45,000 | 69.3 | 1,760 | 77.2 | 1,960 | 85.0 | 2,160 | 92.9 | 2,360 | PD-45 | 10,116 | 45,000 | 47.8 | 1,214 | 53.2 | 1,352 | 58.7 | 1,490 | 64.1 | 1,628 |

dbd: maximum design displacement. The values in the above table are based on radius of curvature of 11.8 ft (3.6m) for Mono isolators, and 23.3 ft (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.



Seismic devices

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. In addition, its quality is regularly inspected by independent testing institutes. mageba factories are AISC certified for Major Bridges (CPT, STD, SPE) and also maintain AWS certifications for D1.1 and D1.5.

Certification

mageba RESTON®PENDULUM bearings are designed and manufactured in accordance with "AASHTO Guide Specification for Seismic Isolation Design".

Alternatively, RESTON®PENDULUM bearings can be also designed and manufactured in accordance with European Standard EN 15129 and with EN 1337. Bearings are then 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 are carried out at an independent testing facility and fully supervised by a certified body.

Testing

If required by the client, 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 AASHTO "Guide Specifications for Seismic Isolation Design" or European Standard EN 15129:2009. Upon request, customized testing based on other codes can also be performed.

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, mageba-group.com, you will find further product information, including reference lists and tender documentation.

Reference Projects for mageba Seismic Devices



Awaza Bridge (TM)



Flendruz (CH)



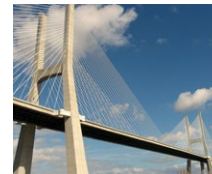
Langenargen (DE)



Ramstore Bridge (KZ)



Agin Bridge (TR)



Vasco da Gama Bridge (PT)

mageba Seismic Devices



RESTON®SA & STU



RESTON®PSD



RESTON®PENDULUM



LASTO®LRB & HDRB



engineering connections®