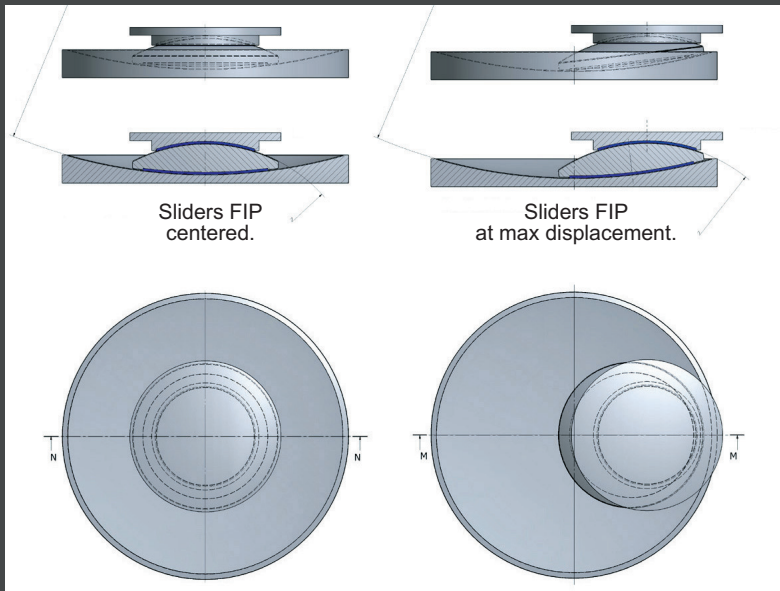




INTRODUCTION

DESCRIPTION

Curved surface sliders in the FIP (Friction Isolation Pendulum) series are steel isolation bearings based on the working principle of the simple pendulum in which the period of oscillation does not depend on the supported mass but on the length of the pendulum.



The FIP devices are characterised by three principal elements: a concave slider (whose curvature radius imposes the period of oscillation), a steel rocker, of which one side is suitably shaped to be coupled to the slider and the other one to the base element that allows the rotation of the whole bearing device.

In order to control the friction resistance that the sliding and rotating surfaces oppose to movement, special thermoplastic materials are used.

The main advantages of this type of isolators lie in the fact that the period of oscillation imposed on the structure is independent on the supported weight, the bearing capacity is independent on the displacements and the reduced thickness.

Whereas it were necessary to reduce the plan dimensions or to satisfy special constructive requirements, it is possible to

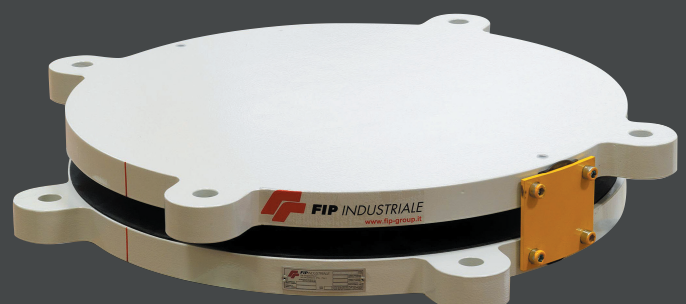
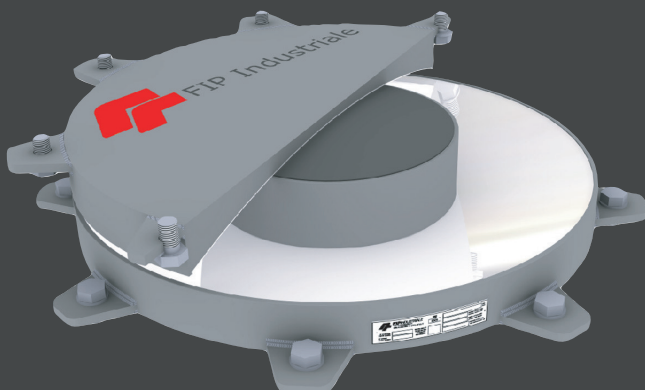
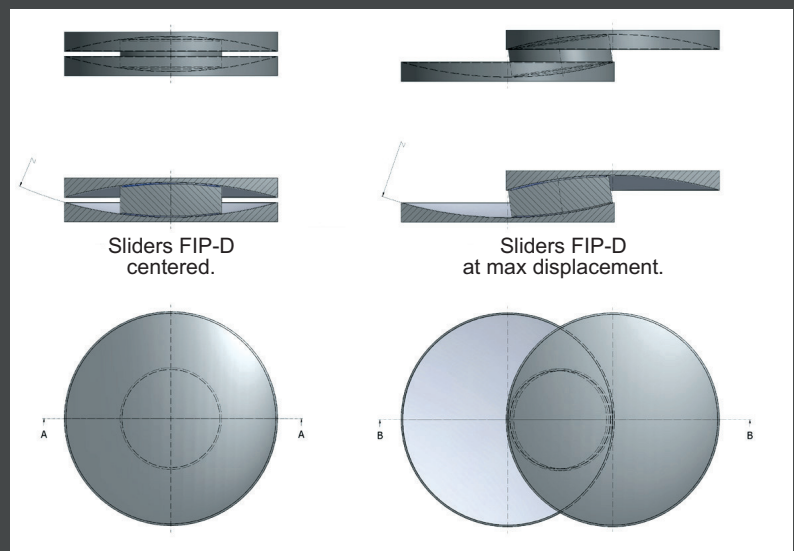
manufacture curved surface sliders with two concave surfaces with the same radius enabling sliding on both surfaces (double curved surface sliders, FIP-D). In this case each single surface is dimensioned for only the half of the design displacement allowing for significantly smaller plan dimensions.

CLASSIFICATION

The curved surface sliders are classified by the mark FIP or FIP-D (Friction Isolation Pendulum) followed by 3 numbers.

The first number represents the maximum static load at ULS in kN/10, the second number represents the total displacement in millimeters, and the third number represents the curvature radius of the concave element in millimeters.

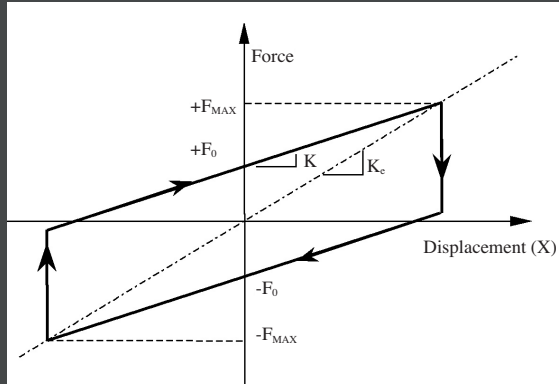
For example, *FIP 800/1000 (4000)* is a curved surface slider of 8000 kN static load at ULS that permits ± 500 mm displacement in all directions, with a curvature radius of 4000 mm.



MODELING

The mathematical model that best resembles the functioning of the sliders in the FIP/FIP-D series consists of a bilinear force-displacement curve whose y-intercept only stands for the friction force $F_0 = \mu V$ developed by the isolator – where μ represents the coefficient of friction and V the effective vertical load.

In turn, the stiffness $K = V/R$ depends both on the effective vertical load and on the radius of curvature R .



When using an equivalent linear model, the equivalent stiffness K_e and the equivalent damping ξ_e as a function of design displacement X will be determined by using the following formulas:

$$K_e = V \cdot \left(\frac{1}{R} + \frac{\mu}{X} \right)$$

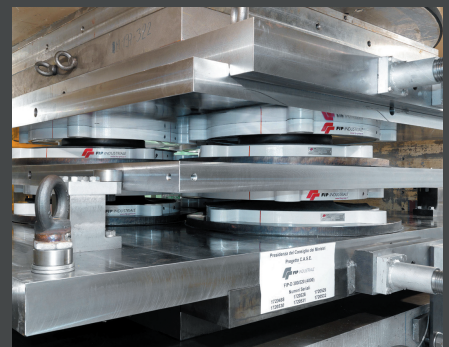
$$\xi_e = \frac{2}{\pi} \cdot \frac{1}{\frac{X}{\mu R} + 1}$$

The oscillation period is the following:

$$T = 2\pi \sqrt{\frac{1}{g \cdot \left(\frac{1}{R} + \frac{\mu}{X} \right)}}$$

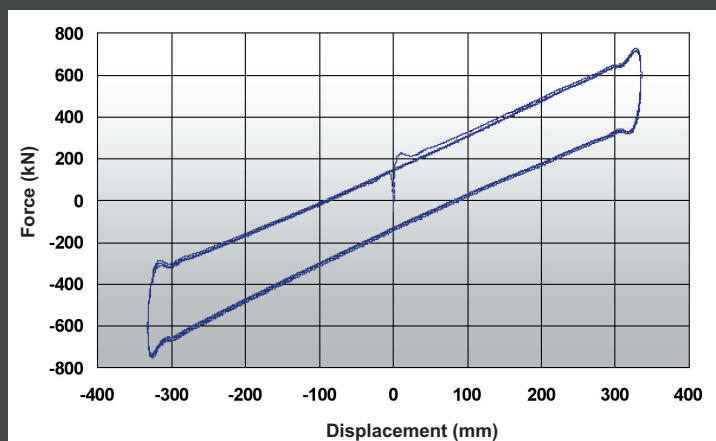
These curved surface sliders commonly provide an equivalent viscous damping ξ_e between 15 and 30% depending on the friction coefficient of the sliding material used, on the radius of curvature and on the design displacement.

The curved surface sliders in the FIP series can be designed so as to satisfy all applicable standards.

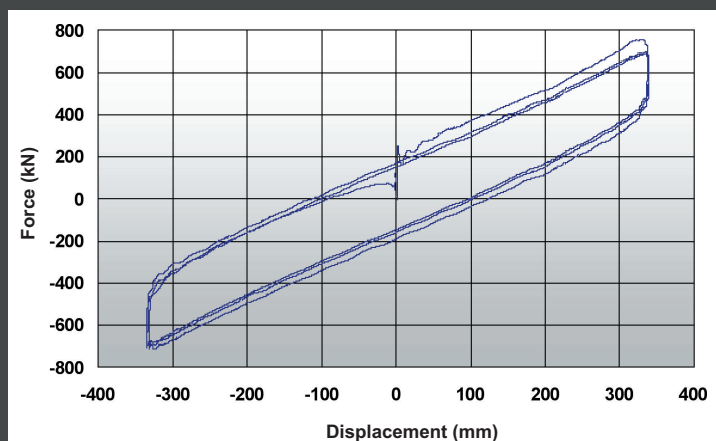


EXPERIMENTAL RESULTS

The results obtained in experimental tests confirm that the force-displacement hysteresis loop of a FIP curved surface slider may be modelled by a bilinear curve, with two significantly different branches of stiffness. Some experimental graphs are here reported.



Experimental hysteretic cycles of a FIP-D 1000/1200 (4202) curved surface slider obtained in a test at constant velocity.



Experimental hysteretic cycles of a FIP-D 1000/1200 (4202) curved surface slider obtained in a test at a sinusoidal velocity.



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