INTRODUCTION

Fip Industriale is world leader in the design and manufacture of seismic devices and provided a significant contribution in the developing of seismic engineering. It started carrying out pioneering researches in 1974, quickly followed by important practical applications (Somplago viaduct in 1976 and Savio viaduct on route E45 in 1977), and has been conducting ever since a vast amount of studies and experiments by its own test laboratories.

Nowadays Fip Industriale's technology makes viscous damper devices reliable, simple in their conception, safe in their performance and economic, also in consideration of the fact that they are designed to be virtually maintenance free.

Viscous damper devices are efficaciously used where relative displacements can occur between two structural elements under dynamic stresses: for example in bridges between deck and abutments or between deck and piers.

Those devices have a constitutive Force - Velocity law of the type \( F=CV^n \) where \( n=0.15 \). Notice that, being \( n \) close to 0, such devices react with an almost constant force in a wide range of velocities. That allows designers to model them with a bilinear Force - Displacement element, characterized by a force independent of the displacement.

The utilization of this technology permits to take full advantage of the strength of structural elements, because it is possible to maximize energy dissipation reaching the maximum level of force that the structure can sustain, without exceeding it.

As a consequence, structural elements remain in the elastic field also during high intensity earthquakes (which would cause great damages in structures without damping devices).

PRODUCT DESCRIPTION

OP and OTP type viscous dampers are basically comprised of a cylinder filled with silicone fluid (oil or paste) and a piston that divides it into two chambers and is free to move in both directions.

In case of sudden movements, due to earthquakes or other dynamic actions like braking, wind, etc., lamination of silicone fluid occur through an appropriate hydraulic circuit and leads to energy dissipation with the behavior explained early on.

In case of slow displacements, due to structure thermal expansion, in the OTP type the fluid flows from one chamber to the other with minimum opposition (normally smaller than 10% of the maximum force), while in the OP type such a flow is obstructed, so that during normal service the behavior is substantially rigid.

All devices can be designed with a suitable system, which allows for fluid volume variations due to temperature changes, and with two ball joints at the ends, which assure the perfect alignment between piston and cylinder, despite possible laying inaccuracies.

OP and OTP type devices can be designed to meet all current standards and design itself, beside production and installation, is realized within a Quality System certified by ICIM and in conformity with UNI EN ISO 9001.
PHYSICAL-MECHANICAL PROPERTIES OF THE DEVICES

The technology used by Fip Industriale manufacturing OP and OTP type viscous devices provides a very stable behavior in the service temperature range, therefore the performance is to be considered constant between -40°C and +60°C and are guaranteed for 35 years. However it is recommended to make a first inspection one year after installation and then every 5 years, to verify and in case to restore the anticorrosive proofing of metallic parts. The following table summarizes the main performance characteristics of OTP viscous devices in their standard version:

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>UNITS</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum velocity $v_{\text{max}}$</td>
<td>mm/sec</td>
<td>Designer's request</td>
</tr>
<tr>
<td>Maximum force $F_{\text{max}}$</td>
<td>kN</td>
<td>Designer's request</td>
</tr>
<tr>
<td>Service temperature range</td>
<td>°C</td>
<td>-40 ÷ +60</td>
</tr>
<tr>
<td>Reaction with velocity ≥ 1 mm/sec</td>
<td>kN</td>
<td>$F \pm 15%$</td>
</tr>
<tr>
<td>Reaction at deck expansion velocity (only for OTP)</td>
<td>kN</td>
<td>$\leq 0.1F_{\text{max}}$</td>
</tr>
</tbody>
</table>

The behavior under dynamic load cycles is shown in the following graph.

![Typical Force Vs. Displacement hysteretic diagram of An OP - OTP viscous device](image)

All the trials on the prototypes are carried out by our Test Laboratories and, on demand, also specific tests on production can be conducted, including static and dynamic tests at ambient temperature and, if necessary, the simulation of the serviceability limit temperature effects.
SCHEME OF THE TYPICAL UTILIZATION OF VISCOUS DAMPERS IN BRIDGES

SCHEME OF THE TYPICAL UTILIZATION OF VISCOUS DAMPERS IN BUILDINGS