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ADAPTIVE CURVED SURFACE SLIDER FOR IMPROVED SEISMIC PROTECTION

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The new adaptive curved surface slider "SIP®-Adaptive" is a curved base isolator with two primary sliding surfaces and an articulated slider whereby the relative motions on both primary sliding surfaces are decoupled (Figure 1) (Weber et al., 2018). This allows designing the two primary sliding surfaces with different friction coefficients and curvatures. The bottom sliding surface 1 is designed with lower friction to provide best structural isolation for weak but frequent earthquakes with shaking levels below and up to the Design Basis Earthquake (DBE). The displacement capacity of sliding surface 1 is limited by a recess to stop relative motion when the ground shaking level is above DBE. The top sliding surface 2 is designed with greater friction to provide optimum damping at shaking levels of the DBE and above. At maximum shaking level of and beyond the Maximum Considered Earthquake (MCE) the SIP®-Adaptive produces increasing stiffness and damping behaviours whereby the total isolator displacement at MCE becomes less than for conventional curved surface sliders.

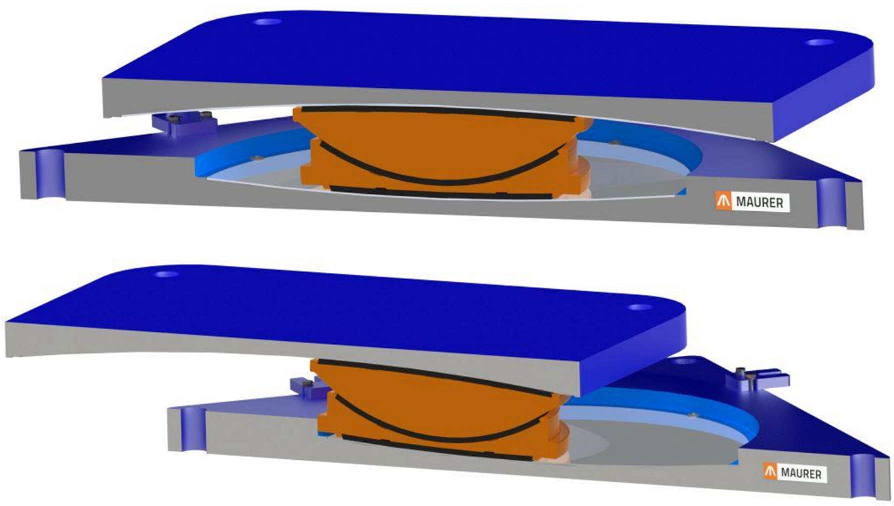

Figure 1. Adaptive curved surface slider SIP®-Adaptive in centre and fully deflected positions.

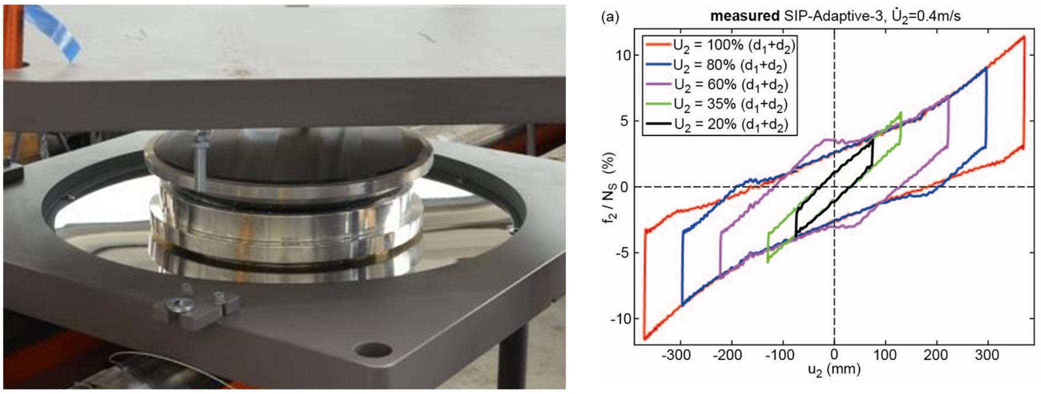

Figure 2. Assembling SIP®-Adaptive and measured (EUCENTRE) adaptive force displacement curves.

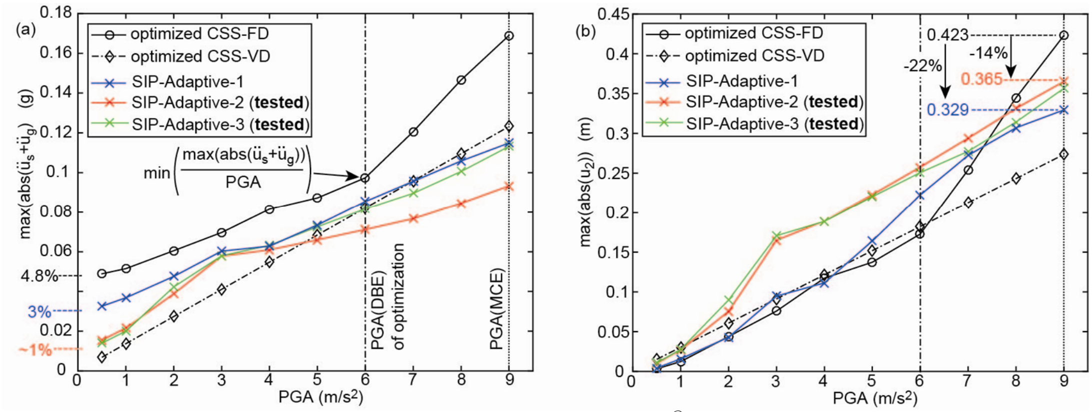

Figure 3. Computed isolation performance of SIP®-Adaptive (types 1, 2, 3).

The SIP®-Adaptive is optimized for the project-specific requirements on maximum base shear, maximum isolator displacement, maximum absolute structural acceleration and maximum re-centring error by non-linear time history analysis (differential equation system given in full paper). The five parameters of the SIP®-Adaptive, i.e. both friction coefficients, both effective radii and the limited displacement capacity of surface 1, are optimized by dynamic simulation.

Several prototypes for CE-marking were tested at EUCENTRE in Pavia, Italy (Figure 2). The measured force displacement curves at various displacement amplitudes confirm the envisaged adaptive behaviour (Figure 2). The isolation performances of these prototypes were then computed by non-linear time history analysis. Figure 3 shows the peak structural absolute acceleration and the total isolator displacement as function of the assumed Peak Ground Acceleration (PGA). The benchmark isolator is the conventional curved surface sliders with optimized friction damping (CSS-FD). The hypothetical CSS with optimum linear viscous damping is also included (CSS-VD). It is observed that the SIP®-Adaptive behaviour is close to that of the hypothetical (ideal) CSS-VD. The SIP®-Adaptive can reduce absolute structural acceleration (~base shear) at all PGAs and total isolator displacement at MCE at the same time. Depending on the design of the SIP®-Adaptive either base shear reduction or isolator displacement reduction is prioritized.

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