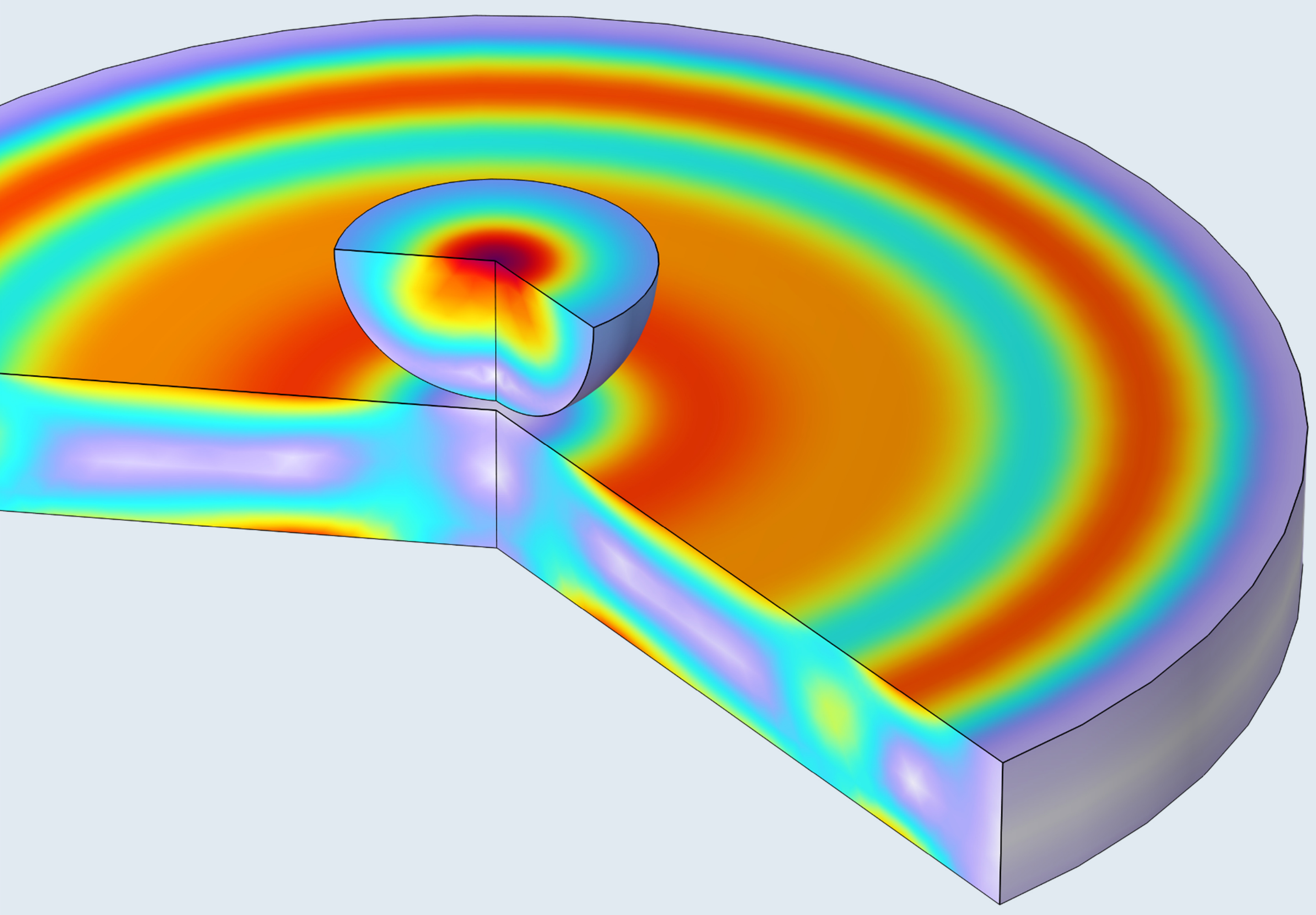

Analysis of Sphere-Plate Collision for Shock Testing

Investigation of contact dynamics for pyroshock testing for aerospace equipment qualification via a resonant plate test facility

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Abstract

Spacecraft and related onboard equipment are subject to strong dynamic loads during the different phases of the missions. Severe high-frequency shocks, mainly caused by the activation of pyrotechnic devices (hence the name *pyroshock*), are transmitted to the entire structure and could cause mission failure and safety-critical damages.

The contact dynamics is strongly affecting the outcome of the tests in terms of Shock Response Spectrum (SRS) acceleration. The scope of this study is to investigate the effect of the main testing parameters over the SRS, in order to wisely select the optimized configuration of the resonant plate test facility.

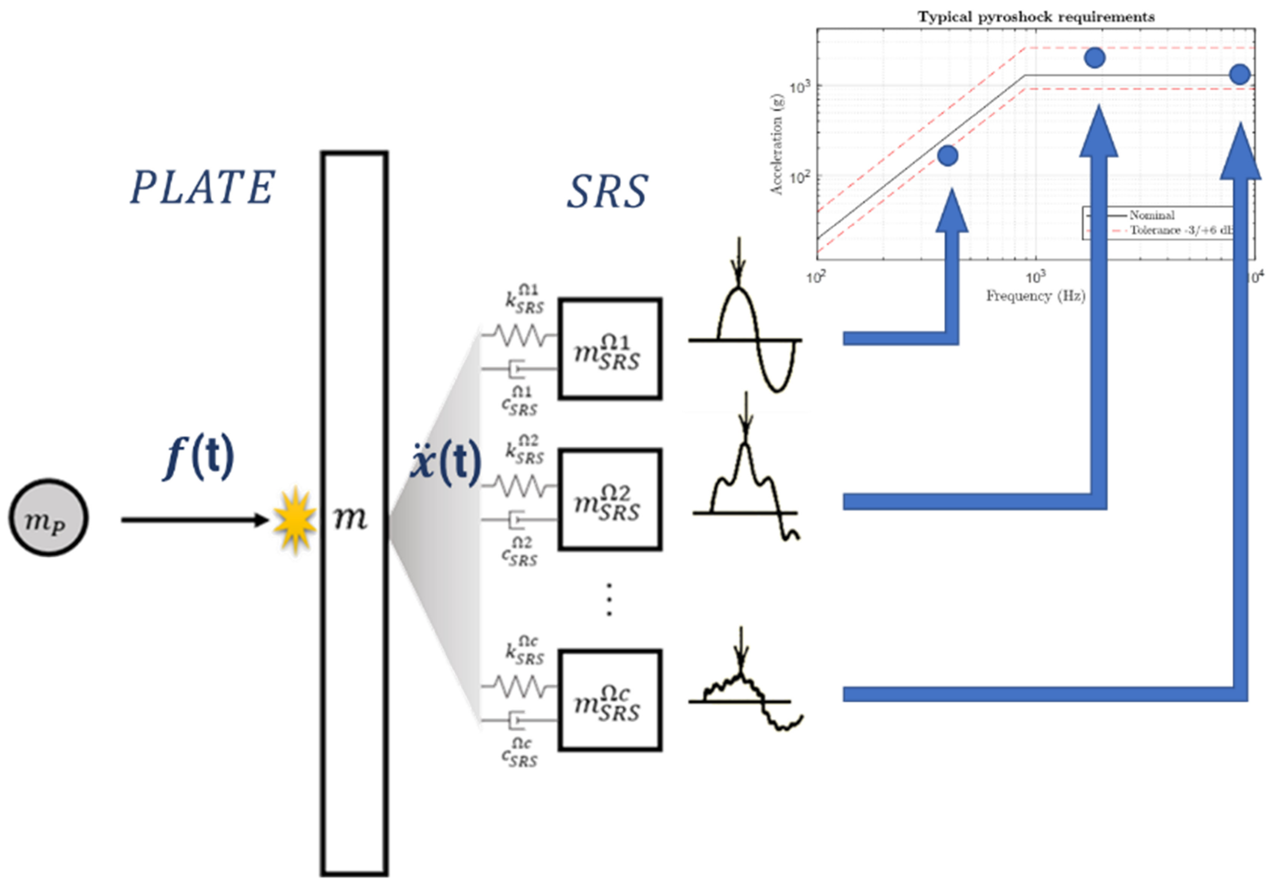

FIGURE 1. A scheme of the physical model.

Methodology

The impacting object (a semi-sphere with radius $r_s = 1\ cm$ and initial speed $v_s = 5m/s$) and a circular resonant plate (with radius $r_p = 5\ cm$ and thickness $z_p = 1\ cm$) have been modeled. The contact dynamics is ruled by the linear elastic material behavior, while the contact pressure in the normal direction is computed according to the penalty method.

The outcomes of this work are expressed in terms of SRS, which is the most commonly used representation to describe the frequency contents of shocks. Figure 1 shows a scheme of the physical model with the SRS computation methodology.

Results

The results can be seen in Figure 2, which shows the time domain response of the plate in terms of acceleration obtained with the COMSOL® contact dynamics model. Both the projectile and the resonant plate are made of aluminum. Figure 2 shows also the SRS comparison computed through the very same COMSOL® model and a reference simulation model developed in [1]. It exists a slight shift in amplitudes at low frequencies, while the first peak coincides faithfully. A further investigation of these results could bring improvements in the shock simulation field.

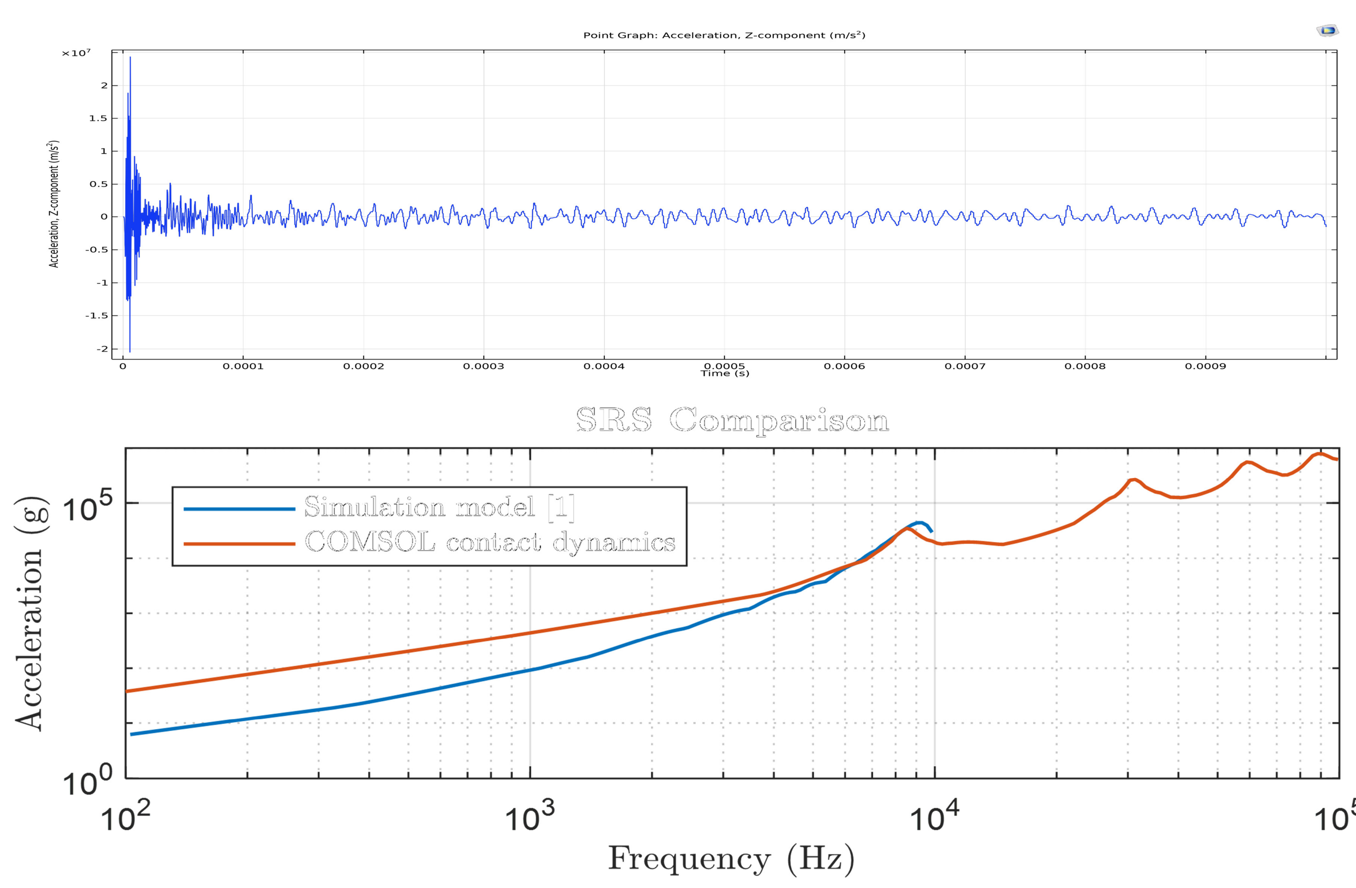

FIGURE 2. Response of the plate in the time domain and comparison of the SRS obtain through the simulation model in [1] and COMSOL contact dynamics

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