What Actually is the Vertical Shock Verbally Reported for Shallow Earthquakes?

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Currently we are investigating the mechanical backgrounds behind two different types of distinct seismic shaking that we may directly experience, even at the same place. One has rather long duration arising from interlocking earthquakes, seismic clusters or earthquake swarms. For example, the recent off the Coast of Fukushima Prefecture earthquake at 23:36 JST on 16 March 2022 itself (moment magnitude 7.3) has records of long duration of shaking of about two minutes, and in addition, it had a foreshock just two minutes before, at 23:34 JST. Hence, the total duration of shaking for this earthquake might be considered to be as long as four minutes. For a deeper understanding of the generation mechanism of this and other seemingly complex rupture processes, we are performing global observations of large-scale material behavior and more local, smaller-scale tracing of development of ruptures and waves in two-dimensional linear elastic brittle solids. The solid materials have sets of digitally fabricated small-scale multiple cracks modeling large-scale geological fault planes that are under quasi-static external loading and dynamic impact (see e.g. Uenishi and Nagasawa, *SSJ Fall Meeting*, 2020, *Procedia Struct. Integr.*, 2022, *Mech. Adv. Mater. Struct.*, 2022).

The other shaking we are paying attention to is the sudden vertical shock that can be felt near the epicenters of shallow earthquakes, even with smaller magnitudes. The strong shock, including that experienced onboard a ship at sea (seaquakes), has been verbally reported quite often for recent earthquakes. However, as reported in Uenishi (*Physics Today*, 2021), while the shaking of long duration caused by (interlocking) earthquakes occurring usually in the far field seems to be relatively correctly (i.e. similar to what we feel) recorded, the abrupt shock coming directly from "bottom" does not seem to have become rightly "visible" in seismograms so far. Rather, the presence of strong shock has been only indirectly supported by several elastodynamic analyses (Uenishi and Sakurai, *Earthquake Eng. Struct. Dyn.* , 2000, *Int. J. Prot. Struct.*, 2014; Uenishi, *ASME J. Appl. Mech.*, 2012) of the unique failures of surface and underground structures generated by the seismic waves in the near field. Here, we shall try to describe some advancement in "unveiling" the mechanical characteristics of the shock by treating recent earthquake swarms attracting considerable attention and other small earthquakes probably drawing much less attention.

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