

“N” -shaped Y/X coda spectral ratio observed for in-line type OBS of S-net and ETMC

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We detected anomalous peak and notch in spectral ratio of Y (perpendicular to cable axis) and X (along cable axis) components of coda wave in frequencies about 5 - 10 Hz and 10 - 20 Hz, respectively, for considerable number of S-net and ETMC (Earthquake and Tsunami Monitoring Cable deployed along the Sagami-Trough) OBS stations. The Y/X spectral ratio shows “N” -shape due to the peak and notch. This “N” -shape is not observed for S-net stations installed at water depths shallower than 1500 m, at which pressure vessels and cables are installed within groove in the seafloor. Seismograms of DONET are buried in the seafloor and do not show the “N” -shape, either. Considering these observations, we think the “N” -shaped Y/X spectral ratio is not caused by horizontal anisotropy below the subsurface medium, but is due to specificity of response functions of X and Y components.

We make a hypothesis that natural vibrations are excited in the pressure vessel due to insufficient coupling of cylindrical shaped pressure vessel placed on the seafloor. The natural vibrations are excited if longitudinal (X component) and transverse (Y component) guided waves incident from both ends of the pressure vessel via connected cables. Depending on the length L of the pressure vessel, these two types of natural vibrations have natural frequencies given by $f_x = V_p/2L$ and $f_y = V_s/2L$, and relationship given by $f_x/f_y = V_p/V_s$ is established. Considering that observed notch and peak frequencies correspond to f_x and f_y , respectively, observed ratio of notch/peak frequencies are around 1.5 to 3 and the ratio seems to be reasonable for V_p/V_s of pressure vessel. Also, since the length L is 2.3 m and 1.6 m for S-net and ETMC, respectively, f_x and f_y of ETMC are expected to be 1.4 times higher than that of S-net: it is actually found in the observed spectral ratio. Not only guided waves but also S-coda wave incidents from coupling zone and vibrates the pressure vessel. If coupling is sufficient, energy of S-coda wave will be much stronger than guided waves and natural vibrations of pressure vessel will become invisible. We think this is the reason why DONET and shallow S-net stations do not show “N” -shaped Y/X spectral ratio.

The “N” -shaped Y/X spectral ratio is likely to be specific to in-line type OBSs having cylindrical pressure vessel placed sideways. Enhancing coupling with seafloor by underwater technologies such as installation within groove and burial would be effective to suppress the emergence of natural vibrations in the pressure vessel. Users of in-line type OBS record without sufficient coupling are recommended to correct response functions of X and Y components if necessary, especially when using frequencies above about 3 Hz.

Keywords: S-net, ETMC, DONET, in-line type OBS, peak and notch in Y/X spectral ratio, natural vibration in pressure vessel, coupling with the seafloor