Supplementary Information: Bridge Monitoring Using Existing Telecom Fiber-Optic Networks

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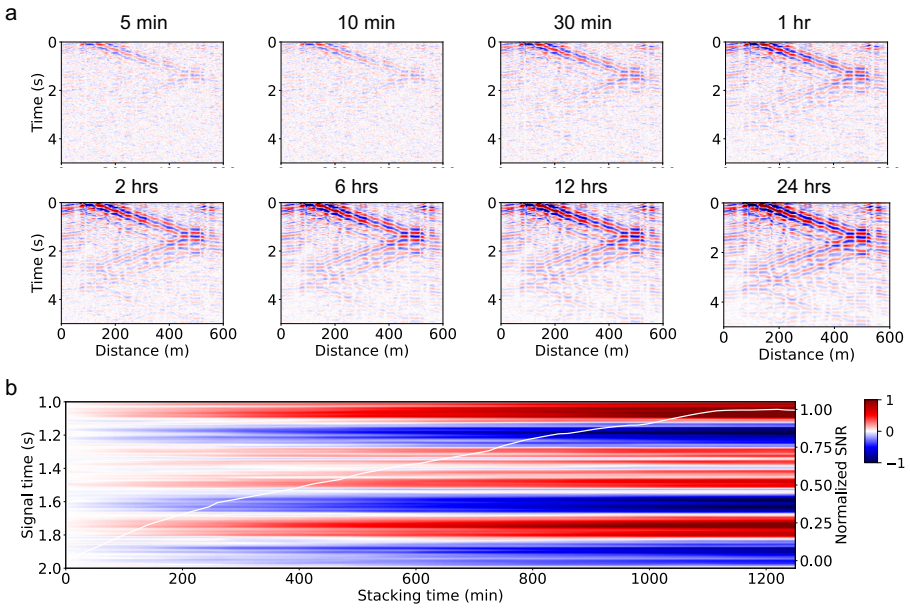

Supplementary Fig. 1: **Influence of stacking duration on the retrieval of guided waves from traffic-induced ambient noise recorded by DAS. a** Virtual Source Gathers (VSGs) obtained via ambient noise interferometry using stacking durations ranging from 5 minutes to 24 hours. A single DAS channel near the left expansion joint is used as the virtual source. Coherent guided wave modes become increasingly visible with longer stacking times, exhibiting stronger signal amplitude and improved continuity across the array. **b** Signal-to-noise ratio (SNR) evolution of a single VSG trace at 300 m offset as a function of stacking duration. SNR is calculated as the energy ratio between a signal window (1–2 seconds) and a subsequent noise window. Results show a near-linear SNR increase with stacking time, with convergence reached after approximately 20 hours.

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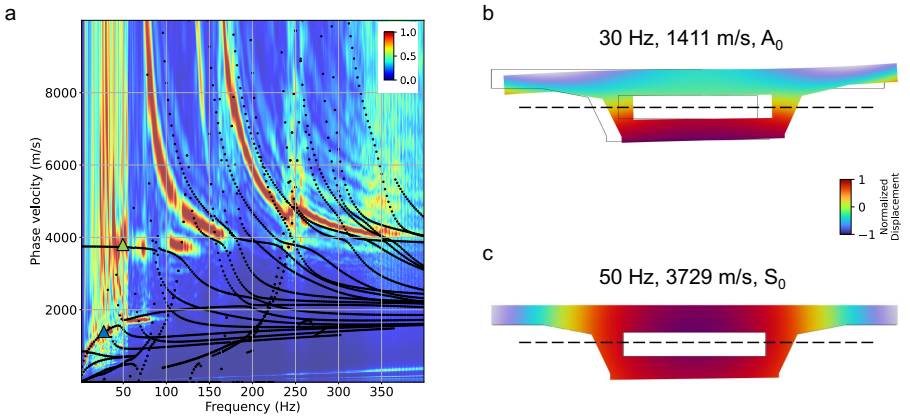
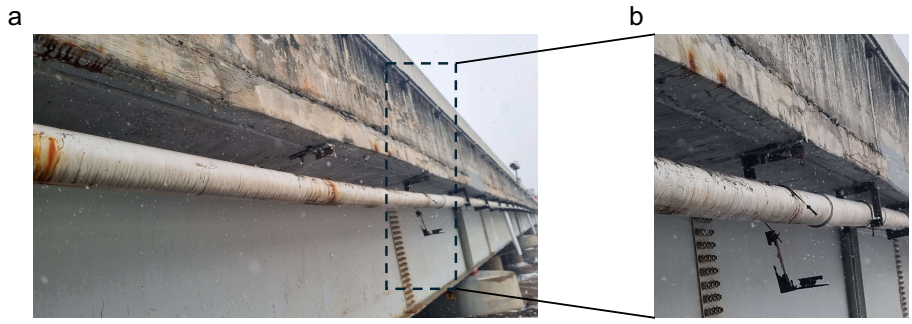


Supplementary Fig. 2: **Dispersion image and mode shapes for the terminal segment cross section of the Miho River bridge. a** Dispersion image derived from the wavefield in Fig. 2d. The image is normalized by frequency to enhance visibility across the spectrum and is overlaid with dispersion curves obtained from the SAFE-based guided wave modeling (black dots; see "Methods" for details). The mode shapes of A_0 and S_0 at 30 Hz and 50 Hz, respectively, are shown in panels **b** and **c**, with blue and green triangles indicating each mode in panel **a**. **b** Out-of-plane displacement mode shape for the A_0 mode at 30 Hz, with a propagation phase velocity of 1411 m/s. The displacement field is anti-symmetric with respect to the central dashed line. **c** Out-of-plane displacement mode shape for the S_0 mode at 50 Hz, with a propagation phase velocity of 3729 m/s. The displacement field is symmetric with respect to the central dashed line.



Supplementary Fig. 3: **Photos showing poor coupling of the telecom fiber-optic cable to the Byeongcheon 2 bridge. b** is a zoomed-in view of panel **a**. Due to inadequate coupling, reliable quasi-static displacement and modal analysis results could not be obtained.