Deep bedrock detection based on ambient noise recorded by a short geophone array: A Singapore case study

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Introduction

Bedrock influences the stability of structures built above it. The depth to bedrock from ground surface also affects the water storage and sub-soil water movement. The passive seismic recordings contain significant amount of low frequency signals, which are mostly originated from urban traffic and anthropogenic noise. Passive seismic based on seismic interferometry is non-destructive and can provides us ideal detection depth. It’s very suitable for bedrock detection in urban environment like Singapore.

<table>
<thead>
<tr>
<th>Phase 1</th>
<th>Raw data</th>
<th>Remove mean, band-pass filter, notch filter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normalization</td>
<td>Spectral whitening</td>
</tr>
<tr>
<td>Phase 2</td>
<td>Cross-correlation within chosen time windows</td>
<td>Stacking all short time windows</td>
</tr>
<tr>
<td>Phase 3</td>
<td>Slant-stack to transform the time-space domain Green’s function to a phase-velocity spectrum</td>
<td></td>
</tr>
<tr>
<td>Phase 4</td>
<td>Dispersion curve inversion for S-wave velocity and information of depth to bedrock</td>
<td></td>
</tr>
</tbody>
</table>

Site location and preliminary processing

Figure 1. Schematic representation of the data processing scheme

Figure 2. Site locations and cross-correlation results in each site

Figure 3. Map of the beach site

Figure 4. Fundamental mode comparison of passive and active data.

Figure 5. (a) (b) Active data and (c) (d) passive seismic comparison

Figure 6. (a) (b) Phase velocity spectrum of active data; (c) (d) Phase velocity spectrum of passive data

Figure 7. Box plot of error with different record length and different observation time

Figure 8. Dispersion curve from optimal array length of 105 m and an optimal duration of 40 min are used for the inversion. (a) shear wave velocity structure from dispersion inversion and the borehole log 330 m east to the array (b) comparison of the observed dispersion curve and synthetic dispersion curves (c) depth to bedrock in best 100 trail models.

Conclusion

- Deep bedrock (> 100 m) investigation can be achieved using passive seismic survey in an urban environment like Singapore.
- The high frequency ambient noise contributes to the distinct body wave reconstruction at beach site.
- Based on a quantitative test, we suggest an optimal array length of 105 m and an optimal duration of 40 min to achieve the balance between efficiency and accuracy required by practicing engineers.

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