SASW Benchmarking Symposium
Geo-Institute Project Sponsored by Geophysical Engineering Committee
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Introduction

Spectral-analysis-of-surface-waves (SASW) has become a common in situ method for characterizing shear wave velocity profiles of geotechnical engineering sites. However, since its development began in the early 1980s, a multitude of techniques have arisen for measuring, analyzing, and interpreting SASW test data. To elaborate briefly, SASW can be collected with two-sensor or multi-sensor arrays, using active or passive vibration sources, and using transient, cyclic, or random sources of vibration. Many techniques exist for determining characteristics of the wavefield, including cross power spectrum phase angle, f-k transform, tau-p transform, and beamformers. Several methods have been implemented for the forward calculation (e.g, propagator matrix, stiffness matrix, finite element method, full-waveform simulation) and for determining shear wave velocities via “inversion” (e.g., linear least squares, nonlinear least squares, damped least squares, simulated annealing, neural networks). To date, a systematic cross comparison of these many techniques has not been accomplished on a common data set, and would be very useful to both the professional and research communities.

It was proposed that a common data set be collected via multiple field techniques and made available to the community for interpretation. The data consists of raw data file records collected from two- and multi-sensor arrays using a variety of active and passive vibration sources. The data was collected at the National Geotechnical Experimentation Site (NGES) at Texas A&M University (TAMU). The TAMU site is well documented, and was recently used for two National Science Foundation (NSF) National Earthquake Engineering Simulation (NEES) projects in the geotechnical engineering area. Equipment for SASW data collection was on-site for conduct of these two projects, and provided an excellent opportunity for this “payload” activity.

The collected data has been posted to a website developed for the symposium, and a public invitation will be broadcast to seek participants. In addition, individuals well-known to the GEC membership will be targeted for their participation. Invitations will request that participants analyze the available data set using their “favorite” techniques, and post results back to the website by a specified deadline. Participants will then be requested to develop and submit papers for consideration in the symposium and a GSP. Finally, the GSP will include documentation developed by the GEC describing the site and data set, and summarizing the results submitted by the array of individual participants. The TAMU site is very well documented, including crosshole shear wave velocity results, and will provide excellent ground truth information for comparison with SASW interpretations.

Objectives

Three files in *.zip format are available for download from the website: Sasw.zip, ActiveMasw.zip, and PassiveMasw.zip. The content of each file is described in detail in the sections below. Testing was conducted with 1-D receiver layouts along a straight line of nearly 400 ft. The positions were marked in one-foot increments from station 0 to station 400. On the mentioned line, three kinds of tests, SASW, active MASW, and passive MASW, were conducted for comparison. It is requested that you analyze as much of the data as you wish, produce one or more shear wave velocity profiles for the site, and then upload your results back on the website. It is requested that your upload consist of just one file, preferably an Excel spreadsheet, and contain the shear wave velocity versus depth results in both tabular and graphical formats. Multiple interpretations of the data should be included in this single worksheet file, and can be differentiated via individual tabs in the worksheet. You will later be requested to produce a paper documenting your results and describing the details of your analysis procedures.

Data Description

1. Sasw.zip

   File contains data from traditional two-receiver SASW tests conducted following standard common receivers midpoint (CRMP) geometry at two positions along the 1-D test line, TestSite61 and TestSite128, where the station number refers to the location of the receiver centerline. At each position, tests were conducted at several receiver spacings, and for shot positions on each side of the centerline to generate forward and reverse wave propagation. The receivers were 1-Hz natural frequency velocity transducers oriented vertically. The active sources were sledgehammers for receiver spacings up to 16 ft, and a vibration shaker for larger receiver spacings.

   An unzip of the Sasw.zip file produces an Excel spreadsheet file Sasw.xls. The spreadsheet contains two worksheets, Sasw_61 and Sasw_128, which correspond with the two SASW test data sets from stations 61 and 128, respectively, and are made available via the named tabs at the bottom of the spreadsheet. Each worksheet consists of 12 four-column data sets according to receiver spacing and source location, and identified via the header information in row 1. For example, the first four-column data set in worksheet Sasw_61 is identified as ΔX = 4f, which corresponds to a receiver spacing of 4 ft and a source location on the forward side of the centerline. Each four-column data set is further described via header information in rows 2 and 4 (row 3 is intentionally left blank). From left to right, row 2 contains the station position for the first receiver (R1), the station position for the second receiver (R2), the station position for the source (S), and the source type (either Sledgehammer or T-Rex Shaker). For example, the ΔX = 4f data set in Sasw_61 contains R1 = 59, R2 = 63, S = 55, and Sledgehammer. Thus, the receiver spacing (ΔX) is 4 ft (ΔX=R2–R1=63–59=4), and the source-to-first-receiver distance is also 4 ft (R1–S=59–55= 4). Row 4 contains header information for the four columns of data beginning in row 6 below (row 5 is intentionally left blank).   The first column is labeled f (Hz), and this column contains frequency in Hz. The second column is labeled |Gxy| (volts), and this column contains the magnitude of the cross power spectrum in volts. The third column is labeled Ph (Gxy) (deg), and this column contains the phase of the cross power spectrum in degrees and in standard ±180 degree wrapped format. The fourth column is labeled Coherence, and this column contains the magnitude of the coherence function.

2. ActiveMasw.zip

   File contains data from multi-receiver surface wave tests conducted using 62 receivers at a spacing of 2 ft, giving a total receiver spread of 122 ft. Two receiver layouts were established at positions TestSite122_0 and TestSite98_220. For each receiver layout, five sets of data were recorded according to five positions of the sledgehammer active source at 10, 20, 30, 40, and 50 ft away from the first receiver, and the results from five vertical blows were averaged to produce the saved record. The receivers were 4.5-Hz natural frequency velocity transducers oriented vertically.

   The first unzip of the ActiveMasw.zip file produces two zip files, ActiveMasw122_0.zip and ActiveMasw98_220.zip, which correspond with the two MASW test data sets from stations 122 to 0 and 98 to 220, respectively. Each of these zip files contain the raw data files collected during the testing and stored in ASCII format. Five data files are included for each set, corresponding to the five locations of the sledgehammer source. The filenames are designated by the first and last receiver station numbers, followed by the station number of the source. For example, filename 122_0_142.txt contains data for test conducted with first receiver at station 122, last receiver at station 0, and source at station 142. Each data file contains 62 columns of receiver amplitudes in volts as a function of time, with column 1 containing data for receiver 1, column 2 for receiver 2, etc. The time interval between each data sample is 0.00078125 sec (0.78125 msec), a pre-trigger delay of approximately 10% of the total record length was used in acquiring the data, and a maximum frequency of 500 Hz was specified for anti-aliasing protection.

3. PassiveMasw.zip

   File contains data from multi-receiver surface wave tests in which ambient signals were recorded by 32 receivers (4.5-Hz natural frequency velocity transducers oriented vertically) deployed at a spacing of 10 ft at station 0 to station 310. The zip file contains 26 independent, raw data file records collected during the testing and stored in ASCII format. Records 1-20 contain data from ambient sources only, while records 21-26 contain data from ambient sources plus a person jogging along the length of the array. Each data file contains 33 columns of data with time in seconds in column 1, and the receiver amplitudes in volts as a function of time in columns 2 through 33. Column 2 contains data for receiver 1 at station 0, column 3 for receiver 2 at station 10, etc. A maximum frequency of 200 Hz was specified during data collection for anti-aliasing protection.