Measured Energy Transfer Application (META): Evaluating Frequency Response of Coastal Structures

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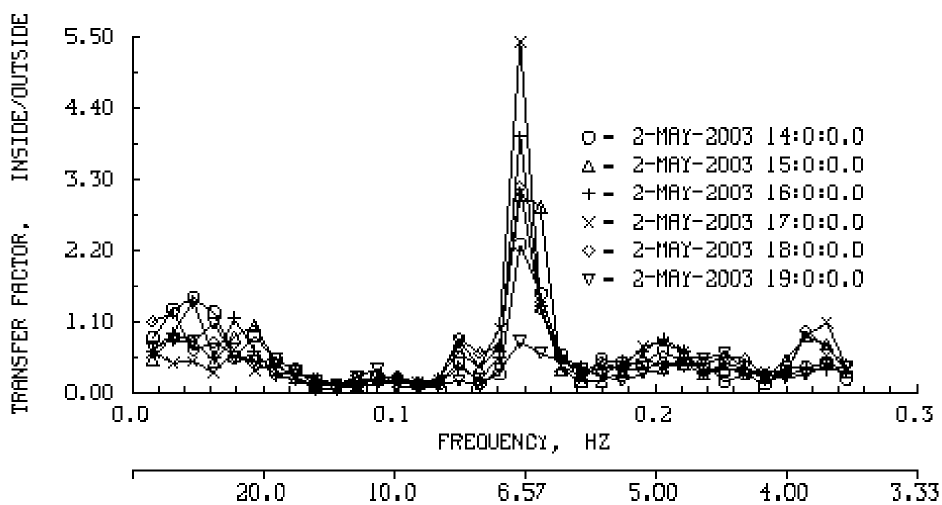
Description

ERDC Coastal and Hydraulics Laboratory (CHL) researchers evaluate the impact of harbor structural modifications on harbor wave climate using the Measured Energy Transfer Application (META). META was developed to refine the estimates engineers use in assessing the effectiveness of coastal structures such as breakwaters, harbor configurations, and channel baffles.

Capabilities

META is a relational technology that determines the harbor wave climate based on offshore wave data. In the past, estimates of harbor wave energy were defined by total energy within the spectrum; however, the harbor wave environment is composed of wave energy in many periods. META, which is an improved methodology, uses coincidental incident and transformed energy spectra to determine a statistical spectral relationship between the spatially separated wave gauging systems. Once the statistical spectral relationship has been defined, META can be used for hindcasts and forecasts of transformed energy using incident conditions.



Measured Energy Transfer Spectra: Energy Ampilification at 6.5 sec for six consecutive wave records

Benefits

Results from META provide engineers with a detailed description and better understanding of navigation or flood protection structural performance. With the detailed information from META, an improved structural design is possible and should provide a more efficient structure.

Success Stories

META has been used recently to determine the effectiveness of coastal structures at three locations: Pentwater, Michigan; Burns Harbor, Indiana; Los Angeles/Long Beach harbors, California.

- Pentwater, Michigan: As part of the Monitoring Completed Navigation Projects Program (MCNPP) support at Pentwater, CHL researchers used META to determine how a channel baffle altered waves in the channel. Underwater pressure sensors were deployed lake side and harbor side of the baffle. Coincidental wave records from the pressure sensors were spectrally analyzed to determine the energy spectra for each gauge location. Coincident spectra were used to compute an energy-transferred spectrum, where for each frequency the energy of the harbor side was divided by the energy of the lake side. The results were added to the Prototype Measurement Analysis System (PMAS) database maintained at ERDC.

- Long Angeles/Long Beach Harbor, California: In work for the Los Angeles District, CHL used the META statistical spectral relationship between long period energy at Queens Gate at Long Beach, CA and a location within Long Beach Harbor to predict conditions at the harbor location using incident conditions. Energy transfer spectra where computed using coincidental wave spectra. The PMAS database was queried to provide records for which the energy of incident waves between 200 and 30 sec > 5.0 cm^2. An average energy transfer spectrum was tabulated from these records and was used to make an estimate of long period energy at the harbor site. The error in the estimate for long period wave during this time period was 21 percent.

- Burns Harbor, Indiana: The META was to determine the effectiveness of repairing a section of breakwater at Burns Harbor, Indiana, as part of studies ERDC conducted with the Chicago District. For this application, energy transfer spectra were computed for two harbor gauges and a directional wave gauge in Lake Michigan. One of the harbor gauges was located behind a repaired section of breakwater while the other was deployed behind an unrepaired section. The PMAS database was queried for records with incident peak period > 5.0 sec in order to compute an averaged energy transfer spectrum for each harbor location. Examination of plots of waves with period >10.0 sec indicate little overall difference in the amount of energy transferred through the repaired and unrepaired sections. However, the repaired section of breakwater reduced the shorter period energy by as much as 50 percent.

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