AN INERTIAL ROTATION METER (TILTMETER)

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Surface tilt noise has always contaminated the outputs of horizontal broadband seismometers at long periods at most surface installation sites. Currently, the only method for reducing or eliminating tilt noise is to install the sensors at depth either in boreholes or in deep caves or mines. For many years instrumentation personnel have known that, if a pure tilt meter were available, the output of the tilt meter could be used to remove the tilt noise from the horizontal sensors that are installed on the surface. The lack of a sensor that is capable of measuring only pure tilt has prevented the application of this method.

In the spring of 2003, a series of preliminary experiments, that was designed to evaluate the feasibility of building a pure tilt meter, was conducted at the Albuquerque Seismological Laboratory (ASL). Parts from two STS-1 horizontal seismometers were combined to create an instrument with a boom with a nearly symmetrical distribution of mass about a central pivot point. The aim of the design was to create an instrument that was relatively insensitive to either horizontal or vertical acceleration and yet could sense pure rotation about an axis in the horizontal plane. An instrument with this design must have an infinite mechanical free period (assuming zero flexure restoring force) if it is to be truly insensitive to horizontal acceleration. The prototype achieved a mechanical free period of about 13 seconds, which is quite a ways from infinity but still a reasonable length. The modified instrument was operated in close proximity with several unmodified STS-1 horizontal sensors in the ASL vault in an effort to determine whether or not the tilt meter could separate pure horizontal tilt from horizontal acceleration.

Initial results have been encouraging. The output signal level of the tilt meter increases under windy conditions as one should expect because wind generates localized tilt of the earth's surface. The output of the tilt meter in response to earthquake input signals is significantly lower than the output of the unmodified STS-1 sensors thereby indicating a significant reduction in the tilt meter's sensitivity to horizontal acceleration. There is significant coherence between the outputs of the unmodified STS-1 sensors and the tilt meter at long periods and relatively simple signal processing has yielded a reduction in the power spectral density levels of the output signal from the unmodified STS-1 sensors thereby indicating that some tilt noise can be removed from the standard sensor output at long periods.

Work on the tilt meter development was suspended in June 2003 due to time and budgetary constraints.