EMS Annual Meeting Abstracts
Vol. 14, EMS2017-725, 2017

Estimating climatic loads for 'extreme' bridges in complex terrain - Observations and analysis of the atmospheric conditions at planned bridge locations in the E39 project of the Norwegian Road Administration

Hálfdán Ágústsson, Øyvind Byrkjedal, and Knut Harstveit
Kjeller Vindteknikk, Kjeller, Norway

In 2014, the Norwegian Public Roads Administration (NPRA) started an evaluation of the climatic loads, pertaining to the construction of a 'ferry-free' road connection between Kristiansand and Trondheim on the western coast of Norway. This implies bridging 8 fjords with widths between 2 and 7.5 km, depths up to 1300 m and typically surrounded by steep mountains up to 800 m. Therefore, a detailed description of the wind, wave and ocean current climate at the proposed crossings is required for the design studies of possible bridge solutions.

The observational program includes 16 tall meteorological masts, 4 of which to be erected in 2017, equipped with 3-dimensional sonic anemometers observing at 10 Hz at several elevations. The most recent masts are 100 m high while the first masts erected have an elevation of 50 m. Masts are generally placed at both ends of the planned fjord crossings. A number of wave buoys with 4 m masts for meteorological measurements are being installed and a campaign including concurrent observations from several synchronized scanning LIDARs will commence in the summer of 2017. All observational data will be put in the open domain. The observational dataset is corroborated by large simulated datasets of weather, atmospheric turbulence, as well as wave and ocean current.

We will present results of the analysis of e.g. individual storm events, estimates of extreme winds with a given return period, as well as a systematic analysis of atmospheric turbulence spectra and coherent structures in the flow. This includes the vertical coherence, at a separation distance of 15 - 30 m, as well as the horizontal coherence, at a separation distance of 8 - 260 m. Significant coherency for like wind components is found for short separation distances, both in the vertical and in the horizontal. Weaker and intermittent coherency is found for long horizontal separation distances and at a relatively long periods (>45 s), and is strongly dependant on the upstream conditions at each site. Examples of individual storm events will be shown, e.g. with vertical wind speeds (3 second average) in excess of +10 m/s,and -22 m/s as an extreme value, immediately downstream of a 500 m high mountain at the site of a proposed fjord crossing. The strong vertical winds are associated with a rather wide sector of winds aloft (180° - 270°), and a change on the order of 15° in background wind direction leads to horizontal wind shift of 100° at lower levels.