

Temperature Effects on the Vertical Movements of the Severn Suspension Bridge's Suspension Cable measured by GNSS

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Key words: Bridge surveying; Engineering survey; GNSS/GPS

SUMMARY

The use of GNSS for the deflection monitoring of large bridges has been an ongoing field of research for 20 years. The Severn Suspension Bridge, in the UK, has a main span length of 988metres. Datasets were gathered in both March 2010 and July 2015 by placing GNSS antennas on the tops of the support towers, as well as on the suspension cables. The data were gathered over four days and three days respectively during these surveys. In addition to the GNSS data, weigh in motion data of the traffic loading, the temperature of the bridge's steel work, and the air temperature and wind speed and direction at a number of locations were collected. In 2010, the temperature during the survey varied between 0.335 C to 13.750 C for the air temperature, and between 0.886 C to 12.390 C for the steel temperature. During the survey in 2015, the temperature for the air varied between 10.800 C to 22.160 C, and the steel temperature varied between 13.820 C to 20.410C.

This paper analyses the vertical movements at the mid-span of the bridge's suspension cable using the data from 2010 and also 2015. The vertical movements are due to a number of reasons. Firstly, the traffic flow will cause rapid changes in the height of the cable, of the order of decimetres due to changes in traffic loading over a time period of seconds or minutes. Secondly, the wind will also cause movements in the cable, but mainly in the horizontal direction. Vertical movements due to the vibrating nature of the cable will also be present, at a rate of 0.1Hz or so. Finally, the cable will expand and contract due to the change in temperature. This will take place over a period of tens of minutes. The relation between the antenna location in 2010 and 2015 are calculated against changes in temperature, and correlation between the movements are shown. The overall movements due to the change in temperature during the survey in 2010 can be shown to be of the order of 0.5 metres, and similarly in

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2015.

The change in a bridge's height, due to a change in temperature is an important parameter to be known. A bridge in the UK could experience changes in temperature from almost 30 C to -10 C in a period of a year during its lifetime. In other parts of the world, this differential could be even more. This could result in a very significant vertical movement of the bridge, which in turn could affect the clearance space under the bridge for passing ships. This type of movement tied with changing tides could result in large ships colliding with such bridges if the clearance is not fully understood.

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