ABSTRACT

Experimental and Numerical Analysis of Thermal Behavior of Composite Bridge Girders

MUSSA, FATEN IBRAHIM

Ph.D. in Civil Engineering Supervisor: Assoc. Prof. Dr. Nildem TAYŞİ

Co-Supervisor: Assist. Prof. Dr. Sallal ABİD

July 2017 164 pages

Due to their permanent external exposure, bridge structures are under the continuous exposure to the temporal thermal loads. These loads are mainly due to the temporal fluctuation of solar radiation and air temperature. In this research, experimental and FE studies were directed to investigate the thermal behavior of composite girders under the variation of solar radiation and air temperature. This research is divided into four parts. In the first, an experimental work including two composite girder segments, T-Beam and I-Beam, was conducted. The segments were instrumented with thermocouples, strain gages and weather sensors. In the second part, a thermomechanical FE analysis was conducted using COMSOL for the two segments, which was verified using the experimental temperature records. Using the verified FE model, a parametric study was conducted in the third part to evaluate the effect of the girder's size. The fourth part was directed to evaluate the long-term temperature variations in Turkey. In this part, the verified FE model in addition to weather history records for more than 50 years of 10 Turkish cities were utilized. The experimental results showed that the temperature variation in concrete parts was higher than in steel for the two segments. Comparisons between the experimental and FE temperatures revealed that the FE models could capture the temperatures accurately. The parametric study disclosed that the thickness of the top concrete flange was the most effective geometrical parameter. The extreme temperature analysis showed that based on the vertical temperature gradients, Turkey can be divided into two regions.

Keywords: Composite I-girder; concrete encased steel girder; solar radiation; thermal load, temperature distribution, temperature gradient