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Climate change effects on design thermal actions for concrete structures

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Abstract

The temperature distribution in a concrete structure varies due to complex interactions with the surrounding climate. Solar radiation, air temperature, wind speed and long-wave radiation all affect the temperature in the material, and may cause movements in the longitudinal and transversal directions. If these movements are restrained, stresses and strains can be induced which may contribute to cracking and other structural problems. A change in the climate may thus have a large impact on the thermal actions and in turn the behaviour of a structure. The representative values in our building codes and regulations are based on calculations using climate data, where the results are analysed using statistical concepts. The climate data used for calculating the design values for thermal actions were obtained during the last half of the 20th century. Due to the projected future climate change, the design values for thermal actions may become outdated in a few years. In this study, the current design loads for thermal actions from different building codes such as Eurocode and AASTHO have been compared with how the design loads may be affected by future climate change. The study shows that the design values for uniform bridge temperature have to be adapted to incorporate effects of climate change. One way is to couple the design value to the service life and an estimation of the temperature change for a certain location, based on climate models. The linear and non-linear estimations may be less affected by climate change due to a smaller effect on the governing climate parameters such as solar radiation and temperature range. The projection is very uncertain however, further studies with more detailed climate models are needed for any conclusions to be drawn regarding these parameters.

Keywords: Climate change, emission scenarios, solar radiation, temperature, thermal effects, concrete, design codes

1 Introduction

Due to durability concerns and more advanced computerized design tools, bridges with larger spans and fewer bearings and joints have been constructed in the latest century. This led to issues with thermal effects which was discovered and analysed from the 1960s and forward [1], leading towards the current design rules, [2], [3], which were developed during the last decades of the previous century. The basis for the design rules and values regarding thermal actions is the climate as it has been in the last 50 years. With the predicted future climate change, these values may become obsolete and may require modifications.

The temperature in a bridge depends on complex interactions in the surrounding environment,

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