Recognising the importance of thermal loading in the Sri Lankan context

I R A Weerasekera*
Department of Civil Engineering, University of Moratuwa, Moratuwa

Concrete bridges exposed to sun are subjected to complex thermal stresses, which vary with time. Although in a tropical climate, there are no large seasonal or daily variations in temperature, large amounts of heat exchanges take place due to solar radiation. This is the main source of heating of bridge decks in the Sri Lankan context. The resulting effect is a differential nonlinear temperature distribution depending largely on the shape of bridge cross section. The magnitude of stresses that are induced can be high and can cause cracking of bridge decks. In simply supported bridges longitudinal self-equilibrating stresses are produced within a cross section. In continuous bridges, there are additional continuity stresses which develop. The resulting effect is a combination of stresses where the principle of superposition is applicable. These stresses induced from thermal loading can be comparable to dead or live load stresses.

Concrete design codes provide very little guidance for thermal loading. Some codes give approximate temperature distributions for heating and cooling. These, however, are not applicable to Sri Lankan bridges. There are methods that could be utilised to ascertain temperature distributions and consequent stresses accurately. Most bridge designers have a false belief that thermal stresses are not very significant for a tropical country like Sri Lanka.

In the present investigation, an attempt has been made to evaluate temperature variation for bridge decks formed using different cross sections commonly used, employing the finite element approach as applied to a heat flow problem. A programme developed in North America based on this concept called FETAB is successfully employed. Corresponding thermal stresses are computed using a package known as CPF, also developed in North America. The comparison of results shows that temperature guidelines provided in the bridge code BS5400 are neither conservative nor meaningful in the Sri Lankan context. The results obtained using such approximate data could be very dangerous. Therefore, thermal effects cannot be disregarded in a robust design. Research conducted at Moratuwa also shows that the bridge beams used in the Industry are over designs so that serviceability problems may not arise from thermal loading. Therefore, the thermal stresses induced may not be trivial. However, techniques available show that accurate and comprehensive calculations can be made. These methods can lead to efficient designs, giving the designer confidence to produce economical bridge cross sections.

* ruwan@civil.mrt.ac.lk Tel : 011-2650567