Ain Shams University
Faculty of Engineering

BEHAVIOR OF CONCRETE BEAMS UNDER THERMAL LOAD

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A Thesis
Submitted in partial fulfillment for the
requirements of the Degree of the M.SC.
in Civil Engineering.

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Cairo-1993

الله

بسم الله الرحمن الرحيم

قالوا سبحانك لا علم لنا إلا ما
علمتنا إنك أنت العليم الحكيم .

صدق الله العظيم
البقرة - ٣٢ -

بسم الله الرحمن الرحيم

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Date : OCTOBER,1993

STATEMENT

This dissertation is submitted to Ain Shams University for the degree of M.Sc. in Civil Engineering.The work included in this Thesis was carried out by the author in the Department of Civil Engineering , Ain Shams University, from October 1986 to October 1993. No part of this Thesis has been submitted for a degree or a qualification at any other University or Institution.

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Title of Thesis " **BEHAVIOR OF CONCRETE BEAMS UNDER THERMAL LOAD** "

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Abstract: Concrete structures are subjected to continuous heating and cooling from the environment and the weather conditions. This causes additional deformations and stresses which must be considered in the design to avoid excessive cracking. In some cases, the temperature variations within the structure may cause stresses which are comparable in magnitude to stresses induced by live and dead loads.

The temperature distribution throughout a structure has to be known to calculate the resulting stresses, reactions and deformations. There are various parameters that affect the temperature development and consequently the stresses induced in reinforced concrete structures such as varying orientation of the structure, air temperature extremes, wind speed, surface conditions and shape and dimensions of the cross section. Therefore, every code suggests a certain temperature distribution to be used in the analysis. Moreover, researchers

suggest certain temperature distributions based on extensive experimental and theoretical analyses.

In addition to the temperature distribution, the accuracy of predicting stresses in the structure during the analysis depends on the extent of considering many factors such as : concrete in tension, tension - stiffening effects after cracking, mechanical load interactions, nonlinear thermal gradients or nonuniformity of cracked members. Any one of the above mentioned factors may be compromised to get accurate predictions in some cases.

In this Thesis, an overview of the methods of predicting the effect of thermal loads on reinforced concrete structures is briefly discussed. One of these methods is applied with modifications, to analyze a bridge example under mechanical loads with various shapes of temperature gradients. These are: (1) Egyptian code.;(2) Nonlinear temperature gradient.; (3) BS 5400 - Part 2 - 1978.;(4) Temperature distribution suggested by researcher. The analysis is performed using the following methods: (1) linear analysis; (2) nonlinear analysis without tension stiffening; (3) nonlinear analysis considering tension stiffening factors. Based on this analysis, the Egyptian Code is found to be safe and conservative and gives a temperature distribution which results in high thermal end actions as compared to BS 5400. On the other hand, the differences between the end-actions resulted from the non-linear temperature distribution and linear temperature distribution suggested in the Egyptian Code are small. Also, the differences in the end-actions resulted from the temperature difference distribution suggested in BS 5400 and the temperature distribution based on the experimental work are relatively small.

Keywords: stiffness; **reinforced concrete**; tension; **stress-strain relationship**; thermal gradients; **thermal stresses**; structural analysis; **temperature**.

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