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"BEHAVIOUR OF COMPOSITE BOX GIRDERS UNDER STATIC LOADING"

By

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بسم الله الرحمن الرحيم

"وما أوتيتم من العلم الا قليلا "

صدق الله العظيم

بسم الله الرحمن الرحيم

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STATEMENT

The dissertation is submitted to Faculty of Engineering, Ain Shams University for degree of MASTER OF SCIENCE in Structural Engineering.

The work included in this thesis was carried out by the author in the Department of Structural Engineering, Faculty of Engineering, Ain Shams University, from 1992 to August 1995.

No part of this thesis has been submitted for a degree or a qualification to any other university or institution.

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TO MY PARENTS

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Abstract for The M. Sc. Thesis Submitted by
Eng. Ahmed Hassan Yousef Aly

"BEHAVIOUR OF COMPOSITE BOX GIRDERS UNDER STATIC LOADING"

Abstract

Steel-concrete composite box girder bridges have a flexible open box section prior to the placement of the slab. Excessive twist or distortion can arise under construction loading. Bracing systems are usually installed within the girder during construction to increase the torsional and distortional stiffness of the open section. Therefore, the influence of these bracing systems on open box girder behaviour will be discussed.

The analysis of single cell box girder is presented using the torsion-bending analysis. A rigid cross section, neglecting any distortional effect, is assumed. The longitudinal stresses arising from both bending and warping moments are computed. Also, a finite element model is presented to analyze the single cell box girder and the different bracing systems. By comparison of the results from the torsion-bending analysis with those from the finite element program, the effectiveness of the different bracing systems in preventing distortion can be found.

The proposed finite element model has been verified by comparing its results with experimental results of previous work. These results showed a good agreement with the experimental results.

A parametric study is carried out to illustrate the effect of different cross sectional shapes of box girders on the distortion of the cross section. The behaviour of composite box girder bridges, after construction of the reinforced concrete slab, under working loads is studied. The purpose of this study is to show the effect of these bracing systems on the total strength of the cross section.

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NOTATION

The following symbols are used in this thesis:

A	The total cross-sectional area of the girder.
t	The thickness of the girder, at the point considered.
s	The curvilinear coordinates taken along the perimeter of the cross section.
σ_b	Bending normal stress.
E	Young's modulus.
τ_b	Bending shear stress.
q_b	Shear flow due to bending.
G	Shear modulus of elasticity.
θ	Twisting angle.
ϑ	The change of twisting angle in the longitudinal direction of the girder.
K	Pure torsion constant.
τ_s	Shear stress due to pure torsional moment.
q_s	Shear flow for a girder with single cell cross section in St. Venant torsion.
$\bar{q}_s$	The torsional function. (in units of cm^2)
m_t	Uniform distributed torque moment applied to the girder.
M_T	Concentrated torque moment applied to the girder.
μ	Poission's ratio.
F	The area surrounded by the closed cross section.
σ_ω	The longitudinal normal warping stress.
u	The warping displacement in the longitudinal direction.
γ	The shear deformation of the segment (dz ds).
r_s	The perpendicular distance from the shear center (S) to the segment (dz ds).
r_o	The perpendicular distance from the centroid (C) to the element (dz ds).

$u(s)$	The warping displacement at any point in the cross section depending on it's coordinate s.
u'	The warping displacement at the origin (s=0).
$\omega(s)$	The torsional warping function. (in units of cm^2)
ω'	An unknown torsional warping function at the origin (s=0).
q_ω	The secondary torsional shear flow.
S_ω	The static moment with respect to the warping function.
I_ω	The torsional warping constant, and represents the geometric moment of inertia with respect to the warping function ω. (in units of cm^6)
T_s	The pure torsional moment.
M_ω	The torsional warping moment.
T_ω	The secondary torsional moment.
σ_B	Bending normal stress under symmetric construction loads.
σ_{DB}	Distortional bending normal stress under symmetric construction loads.
σ_W	Warping normal stress under torsion construction loads.
σ_{DW}	Distortional warping normal stress under torsion construction loads.
σ_{TB}	Total normal stress under symmetric construction loads.
σ_{TW}	Total warping normal stress under unsymmetric construction loads.
σ_T	Total normal stress under eccentric construction loads.
σ_{LB}	Bending normal stress under symmetric working loads.
σ_{LW}	Warping normal stress under eccentric working loads.
σ_{LT}	Total normal stress under eccentric construction loads.

CHAPTER (1)

INTRODUCTION