MODELLING OF SHEAR BOND BEHAVIOUR OF COMPOSITE SECTIONS WITH AXIAL LOADS

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Declaration

The work described in this thesis has carried out in the Department of Civil Engineering, University of Moratuwa, Sri Lanka, under the supervision of Dr. (Mrs.) Manoja Weerasinghe.

The author wishes to declare that, except for commonly understood ideas, or where specific reference has made to the work of other authors, the contents of this thesis has his original work and include nothing, which is the outcome of work done in collaboration. The work has not been previously submitted, in part or in whole to any other University for any degree, diploma or any other qualification.

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Abstract

In this study, the shear bond behavior of steel and concrete composite beams under axial effects has been investigated using the finite element technique. A comprehensive review of various existing theories and finite element models in analyzing shear connection in this type of beams in general, has been conducted and a summary is presented in this thesis.

An effort has been made to achieve a proper shear connection under axial effects, by using a standard linear frame type finite element. In addition, the conventional method of using linear spring elements to model the shear connection in steel and concrete structural elements has also been considered.

SAP90 finite element software has been used for developing all the finite element models presented in this thesis. The finite element models developed have been verified against experimental work conducted by others on a composite stub girder floor system where concrete slab is subjected to bending, shear and axial forces at certain locations.

From the work carried out by this study, it had been concluded that the linear frame type finite element has its limitations in modeling the shear connection under axial effects. However, acceptable shear force values could be predicted in the shear connectors by using this type of finite elements. It has also been found that the conventional linear spring elements developed to model the shear connection may not be valid in the presence of axial effects. However, it may still be possible to use linear spring elements with some modifications to its stiffness. A modification has been proposed in the current thesis to the stiffness of the spring element which had been developed by Ohelers et al. [15].

Content

List of Figures

List of Tables

Notation

A	Area of the section under consideration
A_s, A_{sh}	Area of the shank of the stud shear connector
A_{sc}	Area of the shear stud based on the nominal stud diameter
E	Young's Modulus of material considered
E_c	Young's Modulus of Concrete
E_s	Young's Modulus of Steel
F_{sh}	Longitudinal shear force in steel flange/concrete slab interface (or stud shank/concrete slab interface)
F_{use}	Shear stud tensile strength
G	Shear Modulus concerned
H_s	Shear stud height after welding
I	Second Moment of Inertia
K_{dwl}	Shear stiffness
M_{sh}	Flexural forces in steel flange/concrete slab interface
N_r	Number of shear studs per deck rib
P_{cb}	Characteristic strength of stud shear connectors in longitudinally uncracked composite beams
P_{pr}	Strength of pair of stud shear connectors
P_{ps}	Dowel strength of stud shear connectors
P_s	Shear Strength obtained from Table 32 of BS 5950 [2]
P_{st}	Static Strength of the Stud Shear Connector of BS 5950 [2]
Q_p	Capacity of shear connector in a solid slab to resist longitudinal shear for positive moments; BS 5950 [3]
Q_k	Characteristic resistance of the shear connector obtained from Table 5: BS 5950 [3]
Q_{sol}	Strength of single shear stud
SRF	Stud Reduction Factor (Calculated by Equation (9))
T	Axial force in the element considered
Z	Section Modules (I/y)
d_{sh}, d_s	Diameter of the shank of the stud shear connector

f_c	Cylinder compressive strength of concrete
f_u	Tensile strength of stud material
h_r	Height of the deck rib
n	Proposed factor to the Stiffness of Spring Element
n_r	Number of connectors that can be assumed to fail as a group
w_r	Width of the deck rib
t	Web thickness of an 'I' beam
t_s	Lateral spacing of a stud shear connector in a composite beam
y	Distance to the Centroid form the N/A
μ	Poisson's Ratio of material considered
σ_x	Direct stress in the X direction
τ_{xy}	Shear Stress associated with sides parallel to XY
$\varepsilon_1, \varepsilon_2$	Principal strains at a section considered