AIN SHAMS UNEVERSITY

FACULTY OF ENGINEERING

STRUCTURAL SYNTHESIS OF PREFABRICATED PRESTRESSED CONCRETE BEAMS

BY

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A Thesis

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(Structural Departement)

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بسم الله الرحمن الرحيم

STATEMENT

This dissertation is submitted to Ain Shams University for the Degree of Master of Science in Civil Engineering, Structural Department.

The work included in this thesis was carried out by the author in the Department of Civil Eng., Ain Shams University, from November 1987 to April 1991.

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

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ABSTRACT

The structural synthesis capability for the analysis of simply supported prefabricated prestressed concrete beams is presented. The problem is solved using nonlinear programming techniques. The method of Fletcher & Powell for the optimization of unconstrained fuctions is used with an interior penalty function of Fiacco-Mccormick which accounts for the constrained problems. A comparison between different international codes for the design of prestressed concrete is presented, with the objective of choosing a well defined method of analysis and design for the synthesis procedure. The method of analysis used herein is mainly based on the American Concrete Institute Code (ACI318-89) provisions with some modifications to account for the requirements of the Egyptian Code of Practice for the design of reinforced concrete structures of 1989.

A computer program has been developed for the synthesis scheme under considration. Several numerical results have been obtained which demonstate the capability and effeciency of the optimization system in obtaining minimum weight design automatically.

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LIST OF SYMBOLS

A = area of cocrete at cross section considered, cm^2

A_{ps} = area of prestressed reinforcement in tension zone, cm^2.

A_s = area of nonprestressed tension reinforcement, cm^2

b = width of compression face of member, cm.

d = distance from exterem compression fiber to centroid of nonprestressed tension reinforcement, cm .

d_p = distance from extereme compression fiber to centroid of prestressed reinforcement , cm.

D = dead loads, or related internal moments and forces .

e = base of nabierian logarithms or prestressing steel eccentericity

f_{cu} =charactristic strength of standard concrete cube after 28 days , kg/cm^2

$\sqrt{f_{cu}}$ = square root of charactristic strength of standard concrete cube, kg/cm^2

f_{cui} = charactristic compressive strength of standard concrete cube at time of prestress transefer, kg/cm^2

$\sqrt{f_{cui}}$ = square root of charactristic compressive strength of standard concrete cube at time of prestress transefer, kg/cm^2

f_{pc} = average compressive, stress in concrete due to effective prestress force only (after allowance for all prestress losses), kg/cm^2

β_1 = $0.85 - (F_{cu} - 350)/1400 \geq 0.65$

f_{ps} = stress in prestressed reinforcement at ultimate strength of the cross section, kg/cm^2.

f_{pu} = specified ultimate tensile strength of prestressing tendons, kg/cm^2

f_{py} = specified yield strength of prestressing tedons, kg/cm^2.

f_r = modulus of rupture of concrete, kg/cm^2

f_{se} = effective stress in prestressed reinforcement, (after allowance for all prestress losses), kg/cm^2

f_y = specified yield strength of nonprestressed reinforcement, kg/cm^2

h = overall thickness of member ,cm

k = wobble friction coefficient per meter of prestressing tendon

l_x = length of prestressing tendon element from jacking end to any point, x, m.

L = live loads, or related internal moments and forces

P_s = prestressing tendon force at jacking end

P_x = prestressing tendon force at point X

α = total angular change of prestressing tendon profile in radians from tendon jacking end to any point X

γ = factor for type of prestressing tendon

= 0.40, for f_{py} / f_{pu} not less than 0.85

= 0.28, for f_{py} / f_{pu} not less than 0.90

μ = curvature friction coefficint .

μ = ratio of nonprestressed tension reinforcement

= A_s / bd

μ_{ps} = ratio of prestressed reinforcement

= A_{ps} / bd_p

ω = μ_s f_y /0.8 f_{cu}

ω' = $\mu_s' \; f_y \; /0.8 \; f_{cu}$

ω_p = $\mu_{ps} \; f_{ps} \; /0.8 \; f_{cu}$

q = Nominal shear strength provided by concrete, kg/cm^2

q_u = Factored shear stress at section, kg/cm^2

q_{ci} = nominal shear strength provided by concrete when diagonal cracking results from combined shear and moment, kg/cm^2

q_{cw} = nominal shear strength provided by concrete when diagonal cracking results from excessive princple tensile stress in web, kg/cm^2

q_d = shear stress at section due to unfactored dead load, kg/cm^2

q_p = shear stress provided by vertical component of effective prestress force at section considered, kg/cm^2

f_d = stress due to unfactored dead load at extreme fiber of section where tensile stress is caused by externally applied load, kg/cm^2

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