Challenges for Civil Construction

2008 INTERNATIONAL CONFERENCE

"BRIDGE SCIENCE AND APPLICATIONS WITH ENGINEERING TOWARDS INNOVATIVE SOLUTIONS FOR CONSTRUCTION"

edited by
A. Marques | L. Juvandes | A. Henriques | R. Faria | J. Barros | A. Ferreira

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CCC2008
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Challenges for Civil Construction
"Bridge Science and Applications with Engineering
Towards Innovative Solutions for Construction"

Safety, Sustainability and Rehabilitation with Innovative Solutions

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PREFACE

Originally conceived in the Faculty of Engineering of the University of Porto (Portugal) in 2001, the CCC Composites in Construction Conference moved to Rende (Italy) in 2003 and to Lyon (France) in 2005. Thinking about the new challenges that are increasingly being put forward in civil construction, namely to provide innovative and sustainable materials and technical solutions, it was decided to redefine symbol CCC to mean Challenges for Civil Construction, as it appears in the present edition of the CCC2008 International Conference.

The Organizing Committee is convinced that the CCC2008, with the aim of "Bridging Science and Engineering Applications Towards Innovative Solutions for Construction", will provide a forum for dissemination of new design and construction solutions for Civil Engineering Structures, including issues of great actuality such as rehabilitation of built heritage and health monitoring.

It is the central aim of CCC2008 to bring together engineers, researchers and companies concerned with the new challenges in Civil Construction. For this purpose a set of topics such as Advanced Monitoring Systems, New Cement-Based Materials, Rehabilitation and Durability, Innovative Applications, New Construction Techniques and Systems, Guidelines and Codes and Numerical Modelling was selected to fit the new Conference scope, which received 90 papers, reviewed by an International Scientific Committee. Furthermore, four worldwide recognized researchers were invited to present the following keynote lectures:

- Frieder Seible (University of California, USA):
  "Safety of the New San Francisco-Oakland Bay Bridge"

- Christian U. Grosse (University of Stuttgart, Germany):
  "Monitoring of Structures Using Wireless Sensors and Acoustic Emission Techniques"

- Pedro Pacheco (University of Porto, Portugal):
  "Movable Scaffolding Systems Strengthened with Organic Prestressing"

- Michael Edén (Chalmers University of Technology, Sweden):
  "Design for Sustainable Building. A Swedish Perspective"

Finally, a special session in CCC2008 was dedicated to PhD students, providing them an opportunity to present underway R&D activities; the best contribution will be awarded with a prize.

The present Proceeding includes printed versions of the extended abstracts and keynote lectures, and the CD-Rom includes electronic versions of the full-length papers, published as prepared by and under the responsibility of the authors.

The Organizing Committee of CCC2008 wishes that this will be the basis of a long series of Conferences on updated topics related with Challenges for Civil Construction.

A. Torres Marques

Porto, FEUP, April 2008

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5. REHABILITATION AND DURABILITY

STRESS-STRAIN MODEL FOR PARTIAL CFRP CONFINED CONCRETE

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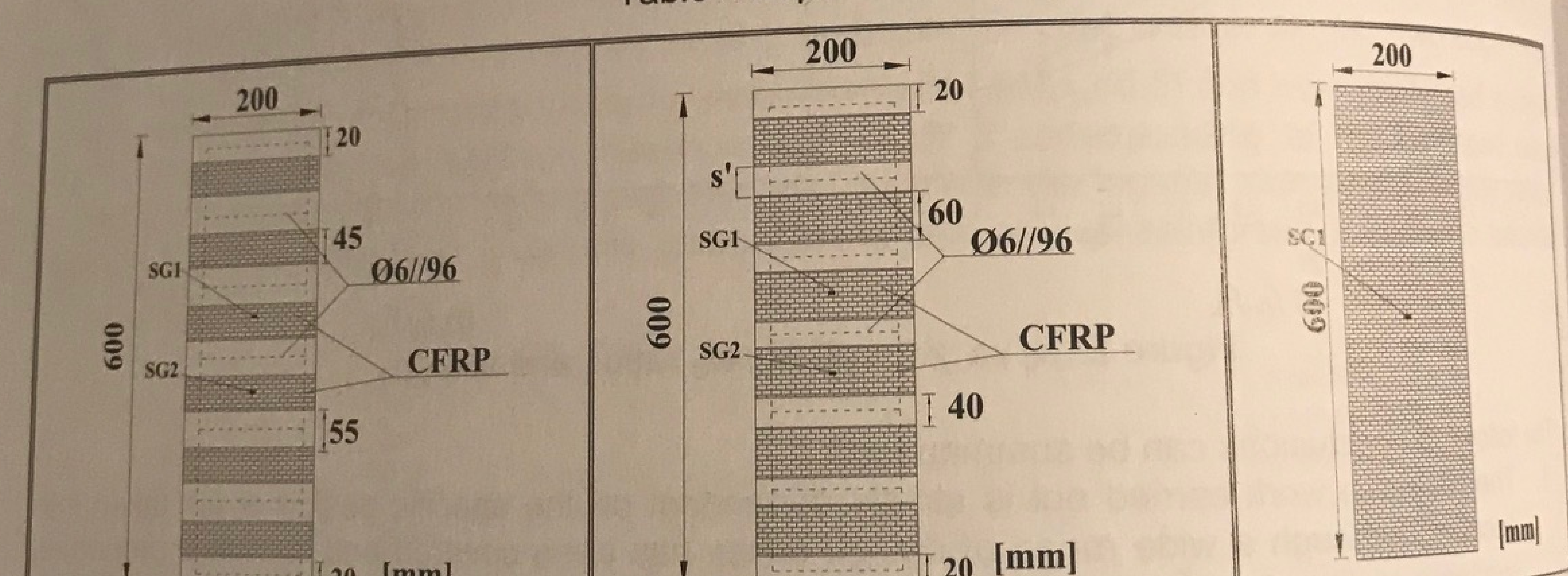
1 EXPERIMENTAL PROGRAM AND CONFINEMENT ARRANGEMENTS

To assess the effectiveness of the partial wrapping technique, RC columns were confined by distinct CFRP arrangements and tested under direct compression. The experimental program is included in Table 1.

Table1: Experimental program.



W [mm]	Designation	s' [mm]	W [mm]	Designation
45	W45S6L3	55	600	W600S1L3
	W45S6L5			W600S1L5
60	W60S6L3	40		
	W60S6L5			
Concrete strength class: C16/20 and C30/35				
Longitudinal bars: $\phi 8$				
Type of CFRP sheet	CF130 S&P 240 (300 gm/m^2)		Group of test series	C16S300ΦS C32S300ΦS
	CF120 S&P 240 (200 gm/m^2)			C16S200ΦS C32S200ΦS

This program is composed by several groups of tests in order to evaluate the influence of the following parameters on the compressive strength and deformation capacity of RC elements submitted, predominantly, to compressive loading: concrete strength class (two average compressive strengths, 16 MPa and 32 MPa); stiffness of the confinement CFRP system (two CFRP sheets, one of 300 g/m^2 of fibers and the other of 200 g/m^2 of fibers); width (W) and spacing (s') of the CFRP strips; number of CFRP layers per strip (L); percentage of the longitudinal and transversal steel reinforcement (ρ_{sl}, ρ_{st}). The present work describes the experimental program and presents and analyzes the obtained results. Using the obtained experimental results, the performance of a model for predicting the behavior of CFRP-based confined RC columns was appraised.

2 ANALYTICAL MODEL

The Harajli et al.(2006) analytical model was modified in order to predict the compression stress-strain behaviour of reinforced concrete column elements partially and totally confined by CFRP lay-up sheets. The main results of the experimental program are presented and analysed in the full paper. The model's performance is assessed using the experimental results. To obtain the σ_c-ε_c relationship the following equations are used (see details in the full paper):

$$\sigma_c = f_{co,URC} + k_1\, f_l \quad \text{for } \varepsilon_c \geq \varepsilon_{cA} \tag{1}$$

$$\varepsilon_c = \varepsilon_{co,URC}\left[1 + k_2\left(\frac{\sigma_c}{f_{co,URC}} - 1\right)\right] \quad \text{for } \varepsilon_c \geq \varepsilon_{cA} \tag{2}$$

where k_1 and k_2 were obtained from the results recorded in the experimental program. Analytical and experimental stress-strain axial relationships (σ_c-ε_c) are compared in Figure 1, from which it can be concluded that the developed model is able to predict, with high accuracy, the axial compression behaviour of CFRP-based confined columns.

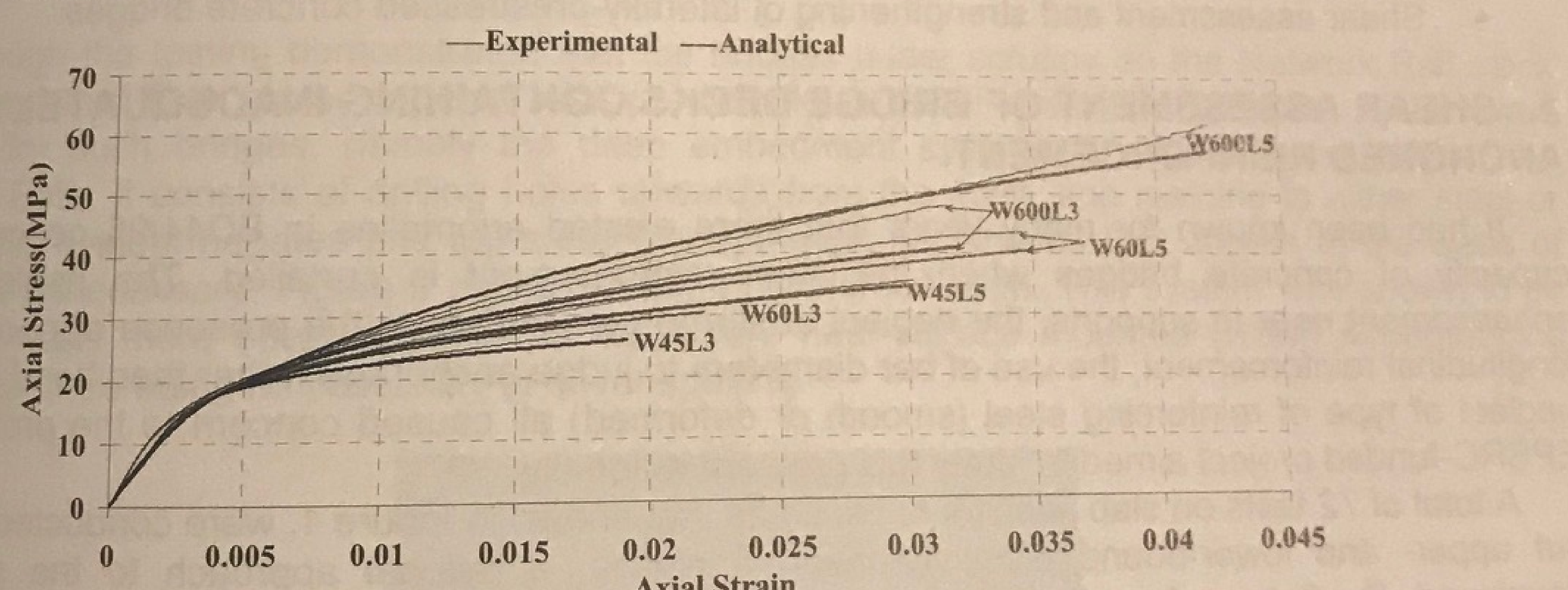


Figure 1: Comparison between the analytical predictions and the experimental results for the C16S200φ8.

3 CONCLUSIONS

The analytical model developed by Harajli et al. to simulate the stress-strain relationship of concrete specimens confined with CFRP was modified in order to be capable of simulating the confinement provided by discrete CFRP-based arrangements. The developed model simulated accurately the stress-strain responses recorded in the experimental program carried out within the ambit of the present work, as well as the tests executed by other researchers.