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Flexural Strength Analysis of Prestressed Concrete Members with High Strength Strands

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Abstract

In recent years, Korean strand manufacturers succeeded in developing 2,160 MPa and 2,400 MPa high-strength strands. The current design codes provide an approximate equation for strand stress at flexural strength. It is because the accurate evaluation of the strand stress requires a complicated nonlinear analysis based on the actual stress-strain relationships. In this study, a material model for high-strength strands was proposed. Using the model, the strand stress and the flexural strength of prestressed concrete members were calculated. And then, they were compared with the predictions by the current approximation equation. The analytical results indicated that the approximate equation can cause an error in predicting the strand stress. However, the approximate equation gave the flexural strengths close to those obtained from the nonlinear analysis. It resulted from the assumption of equivalent rectangular stress block in the design code.

Keywords: prestressed concrete; high-strength strand; material model; flexural strength; strand stress at nominal flexural strength.

1 Introduction

In recent years, there has been increasing interest in high strength structural materials. To meet the need, Korean strand manufacturers were successful in developing 2,160 MPa and 2,400 MPa high-strength strands in 2008 and 2011, respectively. Compared with the 1,860 MPa strands that have been used for the past three decades, improvements in strength have been achieved 16% and 29%, respectively.

To practically use the newly-developed strands, the revised Korean industrial standard [1] included the two types of high-strength strands specified as SWPC7CL and SWPC7DL. In addition, standard test method for anchorage and coupler of prestressing tendon [2] has been developed. Since the Korean design code [3] allows strands to be used for prestressed concrete based on the KS D 7002 standard, high-strength strand is permitted for use in design of prestressed concrete members. However, sufficient investigation on high-strength strands still lacks and the current design code requires a further verification for prestressed concrete members with high-strength strands. Since stress in prestressing strand keeps increasing even after yielding, the current Korean and American design code [4] provide a simple equation to approximate the stress in strand at nominal flexural strength. This equation was developed by Mattock [5] based upon data of prestressed concrete members with rectangular section and 1,860 MPa strands over 30 years ago. Since 1,860 MPa strands and high-strength strands have different material properties such as

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