Structural Design and Behaviour of PSC Beams Prestressed with 2160MPa / 2400MPa Steel Strand

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Summary

This paper introduces newly developed 2160MPa / 2400MPa steel strand for prestressing and its application to PSC girders. Diameter of the strand is 15.2mm which is generally used in Asia and America. Nominal tensile strengths are increased up to 300kN and 333kN for 2160MPa and 2400MPa strand, respectively, from 261kN of 1860MPa strand. This paper reviews the feasibility in structural design aspect of the high strength strands, especially in terms of long-term prestressing losses due to creep, shrinkage of concrete and relaxation of steel. First, the structural design using simplified equations of KHBDC(Korea Highway Bridge Design Code) was compared with numerical analysis result using MIDAS for PSC beam with 2160MPa PS strand. Then, long-term prestressing losses calculated from design equations of KHBDC, Eurocode2 were compared for 35m long PSC beam according to the strength of PS strand(1860MPa/2400MPa). The comparison presented that simplified equations of KHBDC were conservative with no regards to the strength of PS strands and the high strength strands reduce long-term prestressing losses.

Keywords: PSC, 2160MPa strand, 2400MPa strand, long-term prestressing loss

1. Introduction

KHBDC has simplified design equations of long-term prestressing losses due to creep, shrinkage of concrete and relaxation of steel strand. It was adopted from AASHTO highway bridge design specification of early 2000s and it was defined as a function of stresses at concrete after short-term prestressing losses by elastic shortening, friction and relative humidity without considering relative stiffness of concrete and steel(rebar, prestressing strand). The equations were presented to be used only for 1860MPa strand. Therefore, some limitation may be expected to apply it for higher strength strand such as 2160MPa, 2400MPa strands. Long-term behaviour of concrete structure by creep and shrinkage is dependent on how much and where rebar and strand are embedded in its concrete section. In order to manifest the relationship, new design equations considering geometry of the concrete section were adopted in many design code including AASHTO LRFD, EC4. These design equations may be applied for higher strength strands without any modification. In this paper, simplified design equations for 1860MPa strand were compared with FE numerical analysis result using MIDAS in order to find out how well the equations estimated the long-term prestressing losses. Then, a similar comparison was made for 2160MPa strand in order to review if the simplified equations can be an option in estimation of the long-term prestressing losses. In addition, comparisons of design equations were made in the structural design of 35m PSC beam using 1860MPa and 2400MPa strands.

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https://doi.org/10.2749/222137912805111988
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