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# Structural performance of prestressed composite girders with corrugated steel plate webs

Deuck Hang Lee [a,1], Jae Yuel Oh [a,2], Hyun Kang [a,2], Kang Su Kim [a,*], Hyung Jun Kim [b,3], Heung Youl Kim [b,3]

[a] Department of Architectural Engineering, University of Seoul, 90 Jeonnong-dong, Dongdaemun-gu, Seoul 130-743, Republic of Korea
[b] Fire Safety Research Division, Korea Institute of Construction Technology, 451-1 Hwaseong-si, Gyeonggi-do 445-861, Republic of Korea

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ABSTRACT

In this study, the structural performance of prestressed composite girders with corrugated webs was evaluated by conducting experiments on a total of five specimens with the key test variables of prestress level, tendon layout patterns, welding methods, and shear connectors. The test results showed that flexural performances of the prestressed composite girders were superior to the non-prestressed specimen. Partial interaction analyses were also performed on the test specimens to investigate the horizontal shear transfer mechanisms between steel girder and concrete, and their results were discussed in detail.



## 1. Introduction

The demand for horizontal members suitable for long-span implementation continues to rise in civil structures such as bridges, and the demand for horizontal members that enable not only long-span but also floor height reduction has increased in large-scale architectural buildings constructed in downtown areas. Thus, many efforts to develop long-span steel–concrete composite members have been actively made [1–3], and in particular, prestressed composite girders have been recently studied, which are more active ways to ensure serviceability. While prestressing technique has been generally applied to concrete members, it is coupled to a composite girder in this study. Since the prestressed composite girders are very effective for deflection control and strength enhancement, their researches and field applications have gradually increased [4–10].

A typical I-shaped steel beam has a very large axial stiffness, which leads to a very low introduction efficiency of prestress when the prestressing method is applied. However, as shown in Fig. 1(a), the application of corrugated webs can improve the efficiency of prestress introduced to the top and bottom flanges through the accordion effect that occurs due to the low axial stiffness of the corrugated webs when the prestressing forces are introduced and that also enhances the deflection control efficiency. In addition, as shown in Fig. 1(b), the upward camber of steel girder in the prestressed encased composite girder makes it possible to reduce its floor height by $h_{re}$, compared to that of the general composite girder. The conventional composite girders for floor height reduction have disadvantages in stiffness and strength as their section heights reduce. However, a prestressed composite beam can complement it effectively by introducing high-strength tendons. Fig. 2 shows the concept of the prestressed composite beam with corrugated webs developed in this study. The prestressed composite girder with corrugated webs can be advantageous for long-spans, and can be an effective alternative for floor height reduction [11,12].

The accordion effect of corrugated webs, however, is not yet clearly understood, and few studies have been conducted on the behavior of a prestressed composite girder with corrugated webs. Therefore, in this study, the accordion effect, which is induced at the prestressing stage before application of concrete, is quantitatively evaluated by applying the concept of the effective cross-section [11,13], and the flexural behavior of the composite girder is analyzed by the flexural behavior model proposed in this study. The proposed model is based on a cross-sectional analysis, and can be used for the evaluation of the nonlinear flexural behavior of the prestressed encased composite girder in a relatively simple manner. In addition to three test specimens reported in the authors' previous study [12], two prestressed corrugated webbed steel–concrete composite girders have been tested in this study, and their results are discussed in detail. In order to evaluate the effect of

* Corresponding author. Tel.: +82 2 6490 2762; fax: +82 2 6490 2749.
*E-mail addresses:* dklee@uos.ac.kr (D.H. Lee), hahappyppy@naver.com (J.Y. Oh), kanghty@gmail.com (H. Kang), kangkim@uos.ac.kr (K.S. Kim), kimfestival@kict.re.kr (H.J. Kim), hykim@kict.re.kr (H.Y. Kim).
[1] Tel.: +82 2 6490 5411; fax: +82 2 6490 2749.
[2] Tel.: +82 2 6490 5576; fax: +82 2 6490 2749.
[3] Tel.: +82 31 3690 507; fax: +82 31 3690 540.

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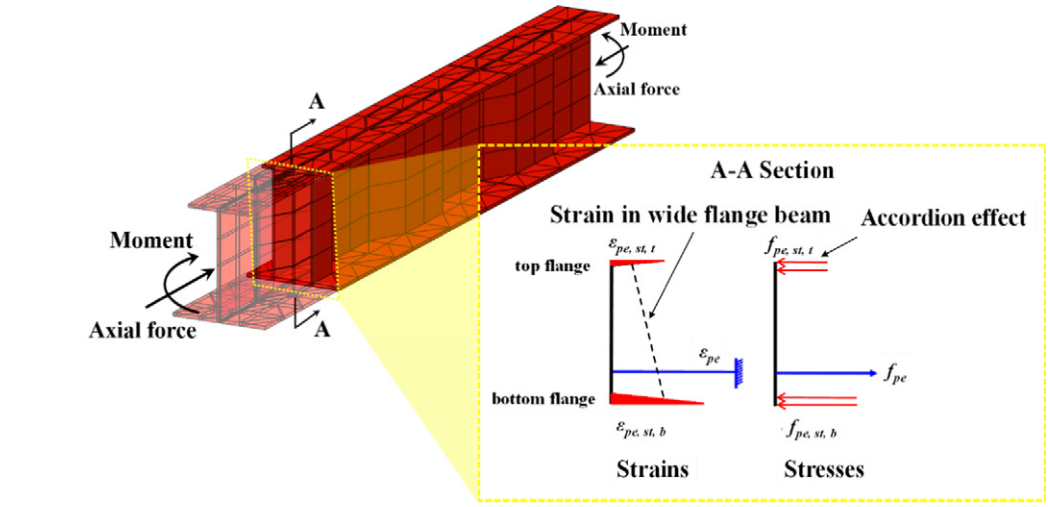
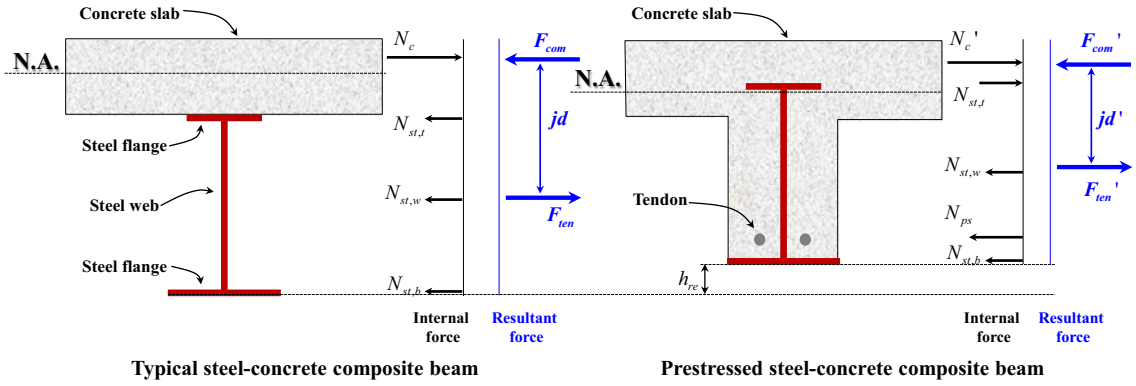



a) Accordion effect




b) Comparison of a typical composite beam and a prestressed composite beam

**Fig. 1.** Characteristics of the corrugated webbed steel beam.

the prestress on their structural behavior, all four specimens were prestressed except the one control specimen. Two types of tendon profiles, one-draped and two-point draped layout, were considered in this study to investigate the difference in their flexural behavior according to the tendon profiles. The effect of welding methods between corrugated web plate and flanges was also investigated, for which one specimen

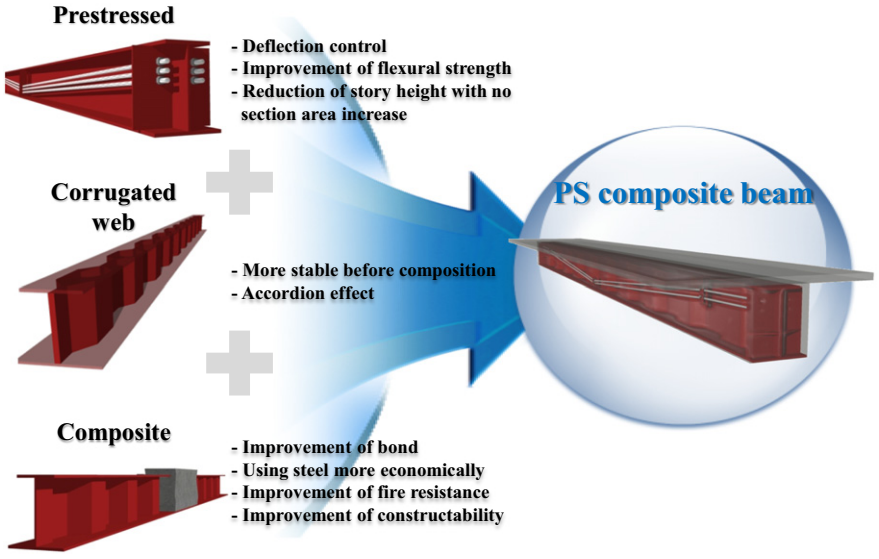



**Fig. 2.** Conceptual description of prestressed composite beam with corrugated webs.