# Study of Vertical Prestress Loss in Concrete Box Girder Webs with Twice-tension Strand Technique

**Yang ZHANG**
Associate Professor
College of Civil Engineering,
Hunan University,
Changsha, 410082, China.
*zhangbridge@163.com*

Yang Zhang, born 1971, received his civil engineering PHD degree from Hunan University, China
His main area of research is bridge structure.

**Xudong SHAO**
Professor,
College of Civil Engineering,
Hunan University,
Changsha, 410082, China.
*shaoxd@hnu.edu.cn*

Xudong Shao, born 1961, received his civil engineering PHD degree from Hunan University, China
His main area of research is bridge structure.

## Summary

To investigate the vertical prestress loss in concrete box girder webs with twice-tension strands technique, a rectangular thin plate test under twice-tension prestressed strands was conducted. At the same time, twice-tension vertical prestress loss used in a practical bridge was also tested, and was compared with the traditional vertical prestressed system using fine-rolled twisted steel bars. Test results confirmed that the immediate vertical prestress loss can be reduced to less than 10% by the twice-tension technology and far less than that of fine-rolled twisted steel bars system. Twice tension system can improve efficiency of vertical prestress and shear reliability in concrete box girder webs effectively. At last based on the test results, some factors that affect twice-tension vertical prestress loss including pipe roughness, joint compression, deformation and retraction of anchorage, elastic compression of concrete, relaxation of tendons and creep & shrinkage of concrete, were discussed, and corresponding methods of design taking value were suggested.

**Keywords:** Box-girder bridge; web; Twice-tension technique; Vertical prestress; Prestress loss.

## 1. Introduction

Long-span prestressed concrete (PC) box girder bridges have been used widely in china, and many benefits have been obtained so far. But, concrete cracking in PC box girder bridges is a common problem that still does not been solved very well until now, and most of them are about inclined cracks in webs. The web inclined cracks not only can lead to the reduction of bearing capacity and stiffness of bridge, but also accelerate the corrosion of steel bars and reduce the structural durability [1-7]. Web inclined cracks in box girder webs are caused by many reasons, but lock and failure of vertical prestress is the main factor [1,4].

Currently, the fine-rolled twisted steel bars are applied to vertical prestress in web of long-span PC box girder bridges. Investigations of practical bridge show that various elastic-plastic prestress loss of the fine-rolled twisted steel bars system has a large proportion because of larger actual retraction of anchorage (about 6mm), low stretching stress and short extension amount of the bars [8-10]. Besides, the fine-rolled twisted steel bar is rigid cable, so the installation of nut, steel bar and anchor plate must be of high precision in construction. Otherwise, it will easily lead to the anchor nut can't be tighten and to a severe decrease of the perpetuate prestress in structure.

In view of the shortages of vertical prestress system with fine-rolled twisted steel bars, some bridge engineers have tried to use steel strand with the features of flexibility, high strength and long extension amount instead of the fining twisted steel bars in vertical prestress system of PC box girder. Nevertheless, as for short strand, the considerably large retraction loss of clamp anchor still can't be eliminated. So the authors developed the vertical prestress system in box girder web with twice-tension strands technique, the corresponding anchorage is shown in Fig.1.

Working principle of twice-tension strand technique is as follows: For the first tension, the strand is stretched to designed load, and is clamped tightly by clips inside the anchor cup after relaxation. For the second tension, the strand once again to meet the design tension stress through stretching anchor

https://doi.org/10.2749/222137912805112707