Development of Bi-Prestressing System in Japan

Développement de système de précontrainte double au Japon

Entwicklung der kombinierten Zug/Druck-Vorspannung in Japan

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1. INTRODUCTION

In designing prestressed concrete beams as slender as possible, it is well known that the minimum girder depth is often determined with the increasing stress at its compresive fiber because of the concrete stress reaching to the allowance.
A post-compressioning prestressing system is one of the most effective methods that decrease the compressive stress of concrete. Ordinarily the post-compressioning prestress is generated with high strength steel bars, which are arranged in the top frange of the beam and then compressed and fixed to the beam-ends.
As shown in Fig.1, Bi-prestressing system consists of the post-compressioning prestressing system and the conventional pre- or post-tensioning prestressing system, and combining these twin prestressing systems, it is possible to control the stress of concrete freely. If designers determine a suitable prestress distribution in the concrete, the beams can be made slenderer.

2.REDUCTION OF GIRDER-DEPTH

In these six years, from 1985 when bi-prestressing system was used in Japan for the first time (Kawabatabashi foot-bridge, L ≒ 58m span simply supported) up to the present, 36 more bridges have been constructed or under construction by the same method. Fig.2 shows data of these bridges in relation to girder-depth and span length. As can be seen from Fig.2, more than half data of the bridges-span gather around L=30m length and the ratio of depth against span (h/L) extends to 1/38 and the mean of ratios becomes about 1/32. They show the tendencies of the demand for reduction of girder-depth in designing medium to short span bridges.
These results have been brought about under the special circumstances in Japan, for instance, condition of the traffic facilities which are crossing complexly one another, complicated dispositions of structures and private lots, and rapid rise of land price which causes a difficult procurement of lots. In these situations, it sometimes becomes inevitable to reduce more the depth of beams.
In addition, because of a flexible applicability of the bi-prestressing system to girder-sections and erections, the various bridges have been designed and constructed to satisfy each requirements. There have been box-girder or hollow-slab types cast in place and precast I-shape or hollow-section girders erected Consequently, the bi-prestressing system has been employed in the wide-ranging bridges whose span length has been from 16.8m to 65.7m long.

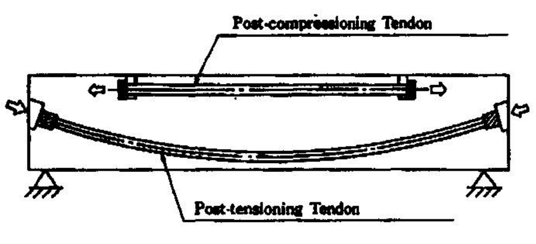

Fig.1 Concept of the bi-prestressing system

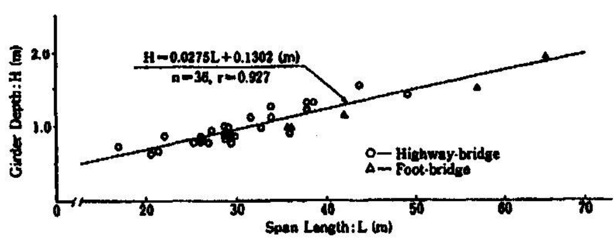

Fig.2 Bridges' data using the bi-prestressing system

3.POST-COMPRESSIONING BAR AND ITS ANCHORING DEVICE

3.1 Steel bar for post-compressioning

There are two types of high strength steel bars made by different manufacturing processes in Japan. In this case, induction heating steel bar is in use of post-compressioning steel, because it is very important for the steel bar to have higher yeild point and long-term stability against high compressive-stress. Induction heating steel bar which is made by high-frequency induction heating, has a high elastic property nearly equal both under tension and compression forces, more-over, can be made into such a large-diameter bar that produces more effective prestress. Its mecanical qualities are shown in Fig.3 with data of the another steel bar which is made by stretching and blueing process.

3.2 Anchoring system

The anchoring system the authors have developed for post-compressioning bar has a simple mechanism that consists of an anchor-plate and recesses in the concrete therefore it is not only economical but also easy to handle. (see Fig.4)
The anchoring device consists of two recesses situated at the top concrete of the beam. The larger one located on the beam end is used for installation of a hydraulic jack which pushes the bar at its end with the rod, taking a reaction against the wall of the recess. The smaller one is used for fixing the bar with a nut which is against a steel plate embedded in the concrete after the required compressive force has been gained in the bar.

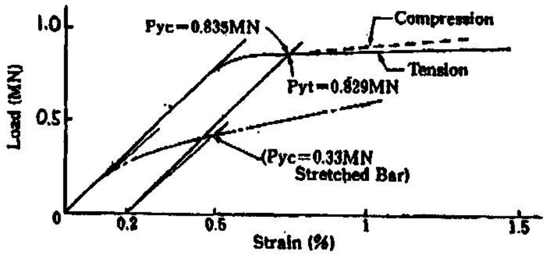

Fig.3 Load-deformation tests on the Steer-bars

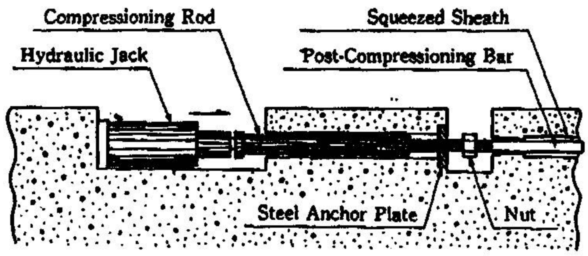

Fig.4 Anchoring device in the beam (Side view)

In conclusion, the bi-prestressing system has been used for mainly reduction of girder-depth as yet,the authors hope that the bi-prestressing system will be put to various uses and will enlarge the application area of prestressed concrete.

REFERENCES

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