Tension Member Prestressing

Zugbandvorspannung

Précontrainte par tirants

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1. PRINCIPLE

A special disposition of the cables for the longitudinal prestressing is suggested concerning continuous prestressed concrete bridges with usual spans and depths. The longitudinal prestressing consists of straight tension members which can only be found in the support zones whereas the normal reinforcement is used in the midspan zones (Fig. 1b and 1c). Since there is no turning round of the tension members problems of durability and fatigue strength are avoided.

The effect of this system can be compared to stay-cable bridges used for wide spans (Fig. 1a). In figure 1 both structures are compared in scale. The figure shows that the cable can be placed within the cross section of the structure of bridges with tension members due to the sufficient overall depth of the structure respectively due to the variable depth (cleat).

The structure can be designed with tension members which are either unbonded or with subsequent bonding. In the latter case the cables are built into a deck slab of a greater depth. In the case of unbonded prestress the tension members can be run within the box girder section. Since the tension members run outside the webs there smaller webs are possible and the construction is also easier.

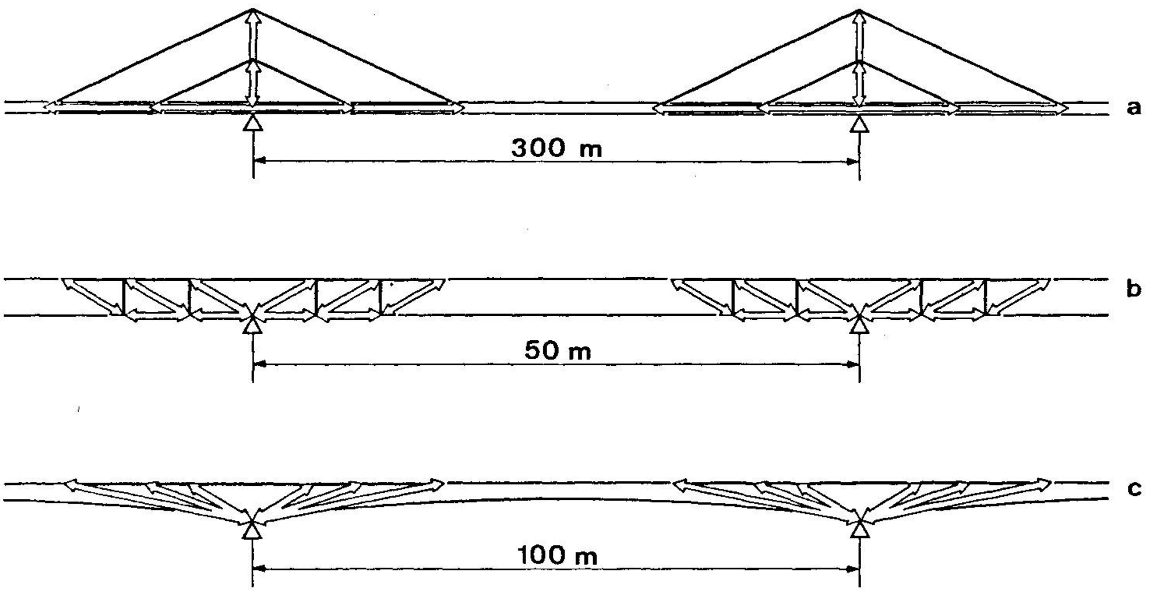

Fig.1: Strut and tie models

2. THE STATICAL BEHAVIOUR AND ECONOMY

The bending effect of a normally reinforced beam is superimposed by the effect of the strut frame within the zone of the tension member (Fig. 1b and 1c). The strut frame strengthens the bending beam in the support zones. The share of the support-moment carried by the strut frame can be controlled by the size of the force in the tension members. Our experience shows that it is economical and recommendable concerning the design to choose the degree of prestress of the tension members in such a way that the strut frame carries the dead load. For the share of the bending beam normal reinforcement is arranged not only in the midspan zones but also in the support zones.

A comparison of the required amount of steel (amount of normal steel plus amount of prestressing steel multiplied by the yield stress ratio) concerning the conventional disposition of prestressing cables with the tension member prestressing shows that the recommendable design requires 20 % less steel, even in the case of the unfavourable effect of unbonded prestressing. This reduction, mentioned above, is a result of short tension members in the support zones only.

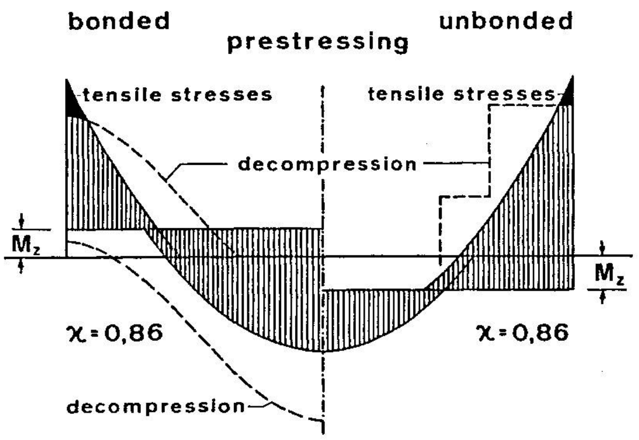

Fig. 2: Partial prestressing - tension member prestressing

Consequently there is a considerable shift of bending moments under working load (Fig. 2). Within the conventional disposition of the cables the prestressing produces positive secondary moments. Owing to that fact the midspan moment increases (Fig. 2,left). On the other hand the tension member prestressing produces negative secondary moments (Fig. 2,right). Consequently the midspan moment considerable decreases.

The normal reinforcement takes care of the cracking control. The prestressing controls the deformation and is required for some methods of construction (e.g. for construction joints with couplings).

3. PROBLEMS OF THE UNBONDED PRESTRESSING

It is generally known that the unbonded prestressing causes extra cost for the cover of corrosion and for the feeding-in of the forces of prestressing. But this higher amount is compensated by the economy of the recommended disposition of the cables. Concerning the costs of maintenance the unbonded prestressing compares favourably to the bonded one. That is proved by the following advantages:

- Since there is no danger of corrosion the degree of prestress can be decreased. The greater amount of normal reinforcement improves the cracking behaviour, the ductility and the durability of the structure.
- Since there are no frictional losses prestress can exactly be adjusted and easily measured.
- Since there is no grouting there are no risks and there are no restrictions concerning weather conditions.
- The cables can easily be checked and can be exchanged without obstruction of traffic.

4. REFERENCES

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