CONCENTRATED LOAD IN ANCHORAGE ZONES OF PRESTRESSED CONCRETE MEMBERS

Abstract: In prestressed concrete structural members, the prestressing force is usually transferred from the prestressing steel to the concrete in one of two different ways. For pretensioned members, the force is transferred by bond between the tendon and the concrete. In post-tensioned construction, relatively small anchorage plates transfer the force from the tendon to the concrete immediately behind the anchorage by bearing at each end of the tendon. As a result of this, large forces, concentrated over relatively small areas are applied on the end blocks. This highly discontinuous forces which are applied at the end, develop transverse and shear stresses. The design of reinforcement in anchorage zone of post-tensioned concrete structures according to European standard is describes.

Introduction

There are generally three areas behind an anchor that need to be reinforced. Immediately behind the anchor are splitting forces due to the tendency of the anchor to be driven into the concrete member by the force of the tendon. Adjacent to the anchor, on the end face of the member, are zones of tensile stress known as spalling zones. Finally, as the prestress force disperses into the member, further zones of tensile stress are created. Anchorages are expected to function satisfactorily for tendon forces of around 95% of the tendon strength, though most of the standards limit the jacking force to about 80% of the tendon strength. It may be permissible to take the design force for anchorage zone reinforcement as equal to the specified jacking force, but it is preferable to design for a force of 90 to 100% of the tendon strength as this provides a useful reserve for a deliberate or inadvertent overstressing of a tendon.

Anchorage zones in post-tensioned concrete

In commercial post-tensioned anchorages, the concrete immediately behind the anchorage is confined by spiral reinforcement (Fig. 1), in addition to the transverse bursting and spalling reinforcement (often in the form of closed stirrups). In addition, the transverse compression at the loaded face immediately behind the anchorage plate significantly improves the bearing capacity of such anchorages.

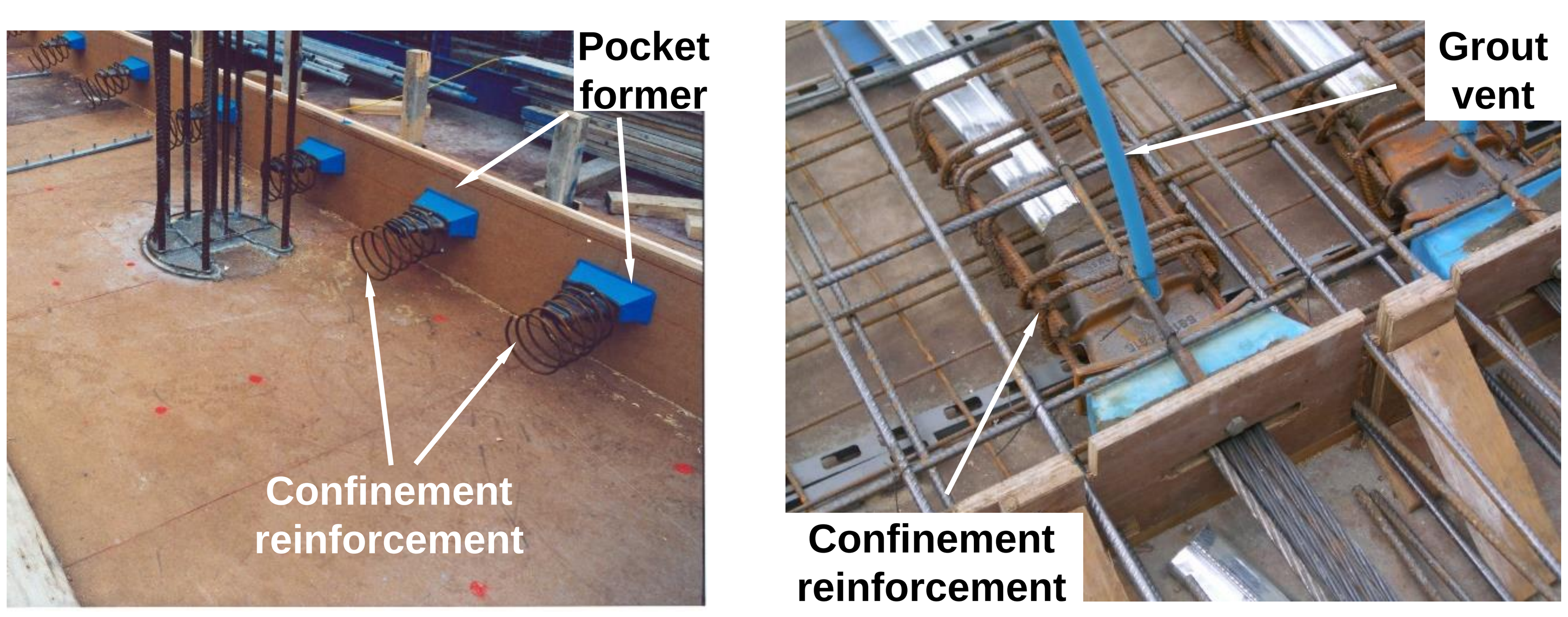


Fig. 1: Live-end anchorage with confining steel

Bearing stresses behind anchorages

In post-tensioned concrete structures, failure of the anchorage zone is perhaps the most common cause of problems arising during construction. Such failures are difficult and expensive to repair, and usually necessitate replacement of the entire structural member. Anchorage zones may fail owing to uncontrolled cracking or splitting of the concrete resulting from insufficient well-anchored transverse reinforcement. Bearing failures immediately behind the anchorage plate are also relatively common and may be caused by inadequately dimensioned bearing plates or poor workmanship resulting in poorly compacted concrete in the heavily reinforced region behind the bearing plate (Fig.2). Great care should therefore be taken in both the design and construction of post-tensioned anchorage zones.

Fig. 2: Tendon failure at the end of the slab

Local concrete bearing failures can occur in post-tensioned members immediately behind the anchorage plates if the bearing area is inadequate or the concrete strength is too low (see Fig. 3). The stres σ_{c1} that can be supported on a bearing area A_{c1} is specified in EN 1992-1-1 as:

$$\sigma_{c1} = {}^{F_d}/_{A_{c1}} \quad \leq \quad \omega_c \cdot f_{cd}$$

$$\omega_c = \sqrt{A_{c2}/A_{c1}} \qquad max \;\; \omega_c \; = \; 3{,}0$$

where f_{cd} is the design compressive strength of the concrete at the time of the transfer, A_{c1} is the bearing area, A_{c2} is the largest area of the concrete supporting surface, with maximum dimensions as indicated in Fig.e 3 (EN 1992-1-1). The centre of the design distribution area A_{c1} is on the line of action of the force F_d passing through the center of the bearing area A_{c1}.

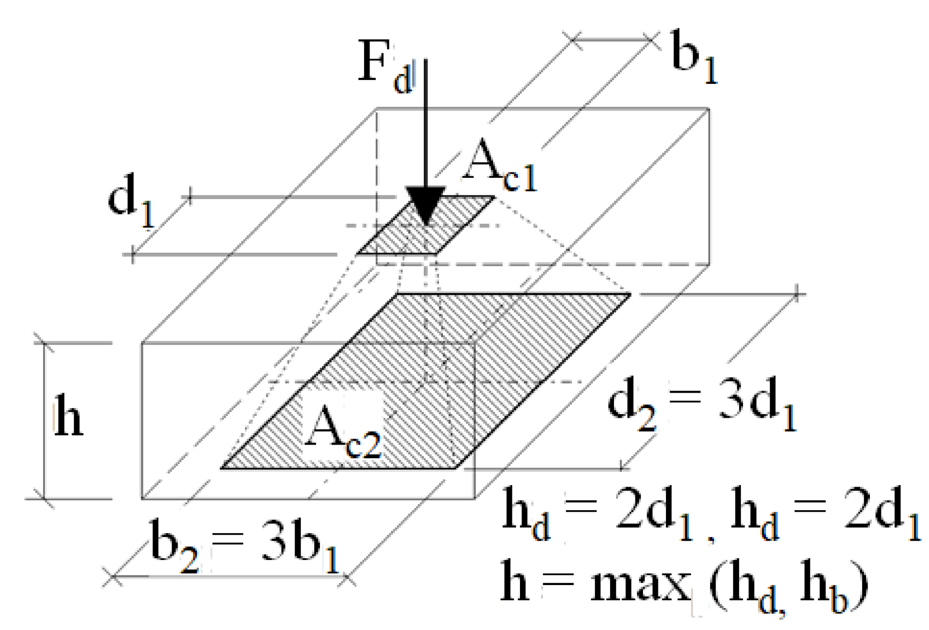


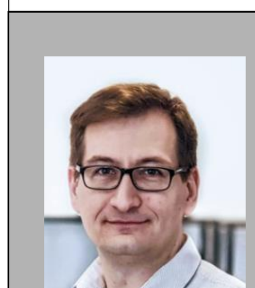
Fig. 3:Design distribution areas for determination of bearing resistance force (EN 1992-1-1).

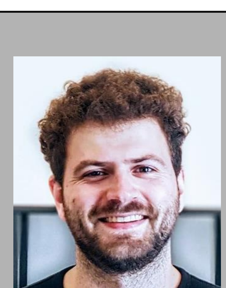
Tab. 1: Values of coefficient ωc.

A_{c2}/A_{c1}	1	2	3	4	5	6	7	8	9
ω_c	1,00	1,414	1,732	2,00	2,236	2,449	2,646	2,828	3,00

Conclusions:

The bearing area of the anchorage is only a small proportion of the concrete area associated with an anchorage. The prestressing force, concentrated on the bearing area, spreads through the concrete, and can be uniformly distributed on the concrete section at a suitable distance from the anchorage. The transverse stresses developed in the anchorage zones are tensile in nature over a large length and since concrete is weak in tension, adequate reinforcement should be provided to resist this tension. The main aim of stress analysis in the anchorage zone is to obtain transverse tensile stress distribution o the end block from which the total transverse bursting tension could be computed. Inadequate reinforcement in anchorage zone of post-tensioned prestressed concrete members may leads to cracking or appalling of concrete. In this paper, the design of rebars in anchorage zone of post-tensioned concrete structures according to EC2 are describes.





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