**CHAPTER V: CONSTRUCTIVE PROVISIONS**

**V.1 INTRODUCTION**

In common cases, the dimensions of the structure are previously defined. If we consider the prestressed elements of the structure, the cross-section of each element is therefore known. It is then a question of calculating the prestress and its losses and defining, after checking the stresses, the layout of the cables. In other more specific cases, the section must be defined when a technical or economic choice is necessary. Concerning concrete, the shape and dimensions of the section to be prestressed must be chosen so that the beam can withstand the imposed stresses. For example, in the case of bending, simple or composite and for the sake of saving weight and concrete, the ratios (I/v) and (I/v') and must be maximum for a minimum area B. The efficiency ρ must be as high as possible.

**V.2 CABLE ROUTES**

After defining the stresses, the characteristics of the sections and the prestress (P and e0), it is necessary to determine the route to be given to the cables in the sections throughout the beam. Two cases arise:

 - The beam is isostatic: the prestress P and the eccentricity e0 apply in the most stressed central section. The cables are raised near the supports to take up the shear forces (because there are no more bending forces at the supports). It should be noted that the exception is: the cables are straight when using bonded wires.

- The beam is hyperstatic: the prestress Pi and the eccentricity e0i must be calculated in all sections. If the prestress is made up of continuous cables, the unknown is the eccentricity e0i, defined by the passage spindle. But this generates an increase in pre-stressing, for the sake of economy; the cables must be stopped in the span. The cables thus sized in certain sections and stopped in others must meet the requirements of:

- Longitudinal bending resistance: in construction and in service (ELS and ULS).

- Resistance to shear force (lifts near supports).

- Numerous practical requirements (coatings, assemblies, vacuum thrust, anchoring, etc.).

**V.3 PRACTICAL ARRANGEMENTS FOR CABLING TRACES**

**V.3.1. Transverse arrangements**

**V.3.2. Longitudinal arrangements**

Longitudinally, duct whistles must be avoided. For high constraints, it is advisable to place gussets to deflect and turn the cables.

**V.3.3. Coverings**

The coating of a duct in relation to any formwork surface is at least 5 cm. For a half-duct in relation to any non-formwork surface, the coating is at least 3 cm. For straight cables in thin slabs (upper or lower slabs of bridges): parasitic deviations create thrusts in the void which can "laminate" the slab and cause it to break during injection. A special case arises for cables outside the concrete: special precautions must be taken for injections.

**V.3.4. Spacing of prestressing reinforcement**

In current section, the horizontal spacing eh and vertical spacing ev of the active reinforcement must be at least 5 cm.

**V.4 FICTITIOUS AVERAGE CABLE**

The prestressing cables in each section form a set that can be quite complex. This is why, for calculations, this set is often replaced by a fictitious average cable that would have, in each section, the same effect as the cables actually installed. The eccentricity of the effective average cable e0 is between (-c' - Mmin/P) and (c - Mmax/P). The segment in which the cable passes is called the passage segment.

**V.5 PASSAGE SPINDLE**

It presents the area delimited by all the passage segments over the entire length of the element.

**V.6 IN POST-TENSIONING PRESTRESSING**

**GROUPING OF PRESTRESSING REINFORC**E**MENT**

The grouping of prestressing reinforcement must satisfy the following conditions: the number of conduits in each bundle is limited: in the horizontal direction to:

q=2 if Փ≤5cm

q=1 if Փ>5cm

In the vertical direction to:

P=3 if Փ≤5cm

p= 2 if 5 cm <Փ< 10 cm

p=1, if Փ≥10cm

**Spacing of prestressing reinforcements**

In current section the horizontal spacing eh and the vertical spacing eV of the isolated conduits or bundles of conduits must satisfy the following conditions:

eh≥ Փ if p ≤ 2

 1,5Փ if p=3

 1,5Փ if q=2

5cm

eV≥: Փ if q=1

 1,2Փ if q=2

4cm

With: p: number of conduit lines (p≤3)

q:number of conduit columns (q≤2)

**V.6.1 Distance of prestressing reinforcements to facings**

The minimum distance between a conduit or a bundle of conduits and a facing must meet the following conditions:

c≥ 3/4a

Փ limited to 80mm

d=3cm: case of structures sheltered from bad weather

d=4cm: case of standard structures

d=5cm: case of structures exposed to an aggressive atmosphere

**V.7 Prestressing by Pretensioning**

**V.7.1 Grouping of prestressing reinforcements**

Prestressing reinforcements by pretensioning must not be grouped in bundles

**V.7.2 Spacing of prestressing reinforcements**

The minimum center distance to be provided between the reinforcements (wires or strands) must not be less than three times their diameter.

**V.7.3 Distance of prestressing reinforcements from the facings**

The distance from the axis of these reinforcements to the nearest facing must not be less than 2.5 times their diameter. In addition, the cover must be at least equal to:

⮚ 1cm for formwork walls located in covered and enclosed premises and not exposed to condensation;

⮚ 3cm for formwork walls exposed to the elements or likely to be exposed to condensation or to contact with a liquid;

⮚ 3 and 4cm, respectively, for non-formwork walls, in the cases defined in the two preceding cases;

⮚ 5cm for structures exposed to an aggressive atmosphere.

**V.7.4 Coating of passive reinforcements**

The coating of any reinforcement must be at least equal to:

⮚ 1 cm for walls located in covered and enclosed premises and which are not exposed to condensation;

⮚ 3 cm for formwork or non-formwork walls which are subjected (or are likely to be) to aggressive actions, or bad weather, or condensation, or to contact with a liquid;

⮚ 5 cm for structures at sea or exposed to sea spray or salt fog, as well as for structures exposed to an aggressive atmosphere.

**V.8 EXERCISES**

**EXERCISE 1:**

We consider an isostatic beam of length 25m, prestressed by three cables of diameter 80mm:

 90

45

40

300

**Data:**

G=61 kN/m, Q=158 kN/m, fcj=30 MPa, P=8.45 MN, Z=2.484 m

1. Determine at a distance of 1 m from the support (α=8°69):

The shear force ELSVG

The shear force ELSVQ

The reduced shear force Vr1 in ELS

The reduced shear force Vr2 in ELS

Shear stress ELS

Compressive stress

1. Determine at a distance of 1 m from the support (α=8°69):

 The ultimate shear force Vru

 The ultimate shear force V′ru

 Ultimate shear stress

 Angle of inclination of the connecting rods