MEMO 65

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TSS 20 FA		Siste rev.:	25.05.2016	Sign.:	sss
REINFORCEMENT DESIGN		Dok. nr.:	K3-10/65E	Control:	ps
DESIGN					

REINFORCEMENT DESIGN FOR TSS 20 FA

CONTENTS

PART 1 – BASIC ASSUMTIONS

GENERAL

The following calculations of anchorage of the units and the corresponding reinforcement must be considered as an example illustrating the design model.

It must always be checked that the forces from the anchorage reinforcement can be transferred to the main reinforcement of the concrete components. The recommended reinforcement includes only the reinforcement necessary to anchor the unit to the concrete.

In the vicinity of the unit the element must be designed for the force R_1.

STANDARDS

The calculations are carried out in accordance with:

- Eurocode 2: Design of concrete structures. Part 1-1: General rules and rules for buildings.
- Eurocode 3: Design of steel structures. Part 1-1: General rules and rules for buildings.
- Eurocode 3: Design of steel structures. Part 1-8: Design of joints.
- EN 10080: Steel for the reinforcement of concrete. Weldable reinforcing steel. General.

The selected values for the NDP's in the following calculations are:

Parameter	γ_c	γ_s	α_{cc}	α_{ct}
Value	1,5	1,15	0,85	0,85

Table 1: NDP-s in EC2.

Parameter	γ_{M0}	γ_{M1}	γ_{M2}
Value	1,05	1,05	1,25

Table 2: NDP-s in EC3.

QUALITIES

Concrete B35/45:	f_{ck} = 35,0 MPa	EC2, Table 3.1
	$f_{cd} = \alpha_{cc} \times f_{ck}/\gamma_c$ = 0,85×35/1,5 = 19,8 MPa	EC2, Clause 3.1.6
	$f_{ctd} = \alpha_{ct} \times f_{ctk,0,05}/\gamma_c$ = 0,85×2,2/1,5 = 1,24 MPa	EC2, Clause 3.1.6
	$f_{bd} = 2,25 \times \eta_1 \times \eta_2 \times f_{ctd}$ = 2,25×1,0×1,0×1,24 = 2,79 MPa	EC2, Clause 8.4.2

Reinforcement 500C (EN 1992-1-1, Annex C):

$f_{yd} = f_{yk}/\gamma_s$ = 500/1,15 = 435 MPa — EC2, Clause 3.2.7

Note: *Reinforcement steel of different ductility grade may be chosen provided that the bendability is sufficient for fitting the vertical suspension reinforcement to the unit.*

Steel Sxxx (EN 10025-2):

S355:	Tension:	$f_{yd} = f_y/\gamma_{M0}$ = 355/1,05 = 338 MPa
	Compression:	$f_{yd} = f_y/\gamma_{M0}$ = 355/1,05 = 338 MPa
	Shear:	$f_{sd} = f_y/(\gamma_{M0} \times \sqrt{3})$ = 355/(1,05×√3) = 195 MPa

DIMENSIONS

Tube: CFRHS 40x40x4, L=215mm. Cold formed, S355

Plastic section modulus: W_{pl}=7010mm^3
Total area: A=535mm^2

LOADS

Vertical ultimate limit state load = F_V = 20kN.

PART 2 – EXAMPLE: ANCHORING REINFORCEMENT IN STAIR

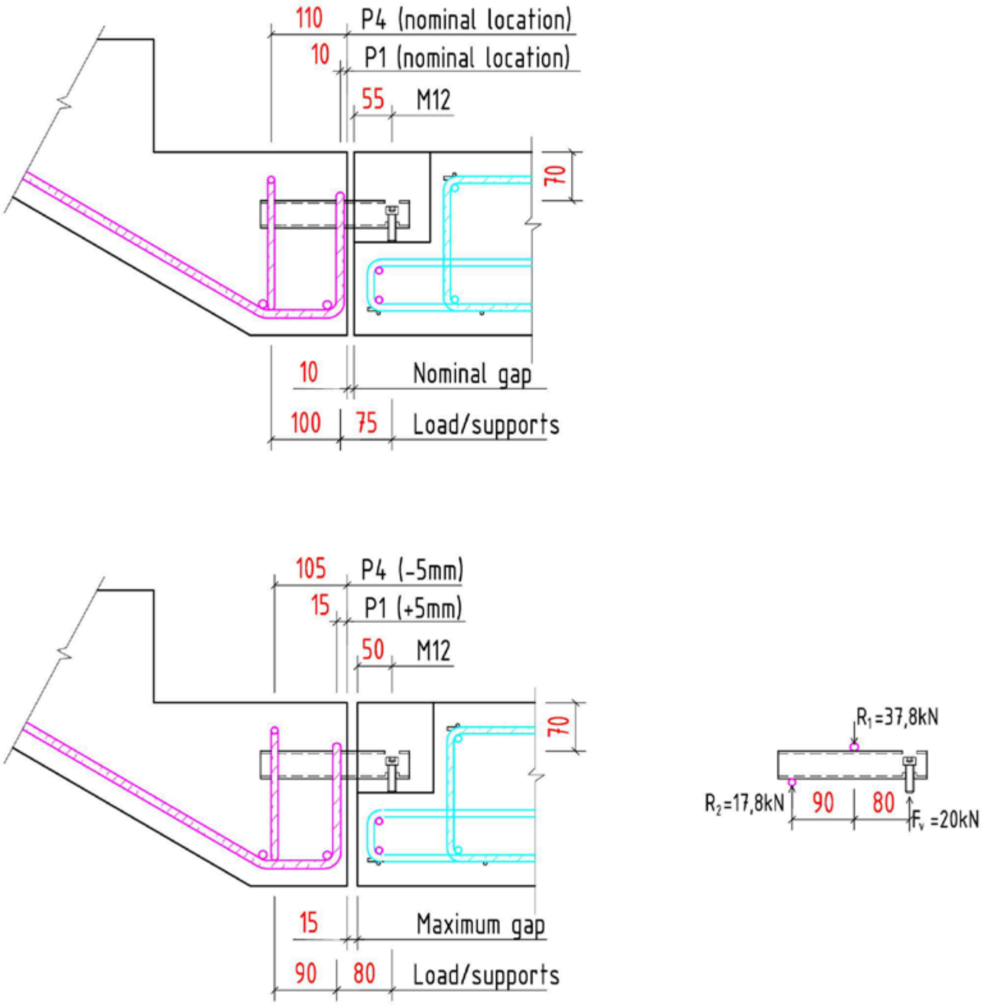

Figure 1: Forces acting on the unit.

F_V = External force.
R_1, R_2 = Support reaction forces.

Capacity is documented based on unfavorable location of the anchoring reinforcement. Tolerances =±5mm

Equilibrium:

$R_2=F_v \times 80mm/90mm = 20kN \times 80mm/90mm=17,8kN$
$R_1=F_v + R_2 = 20kN+17,8kN=37,8kN$

Reinforcement is to be located at the assumed attack point for support reactions.

Reinforcement necessary to anchor the unit to the concrete for R_1 and R_2:

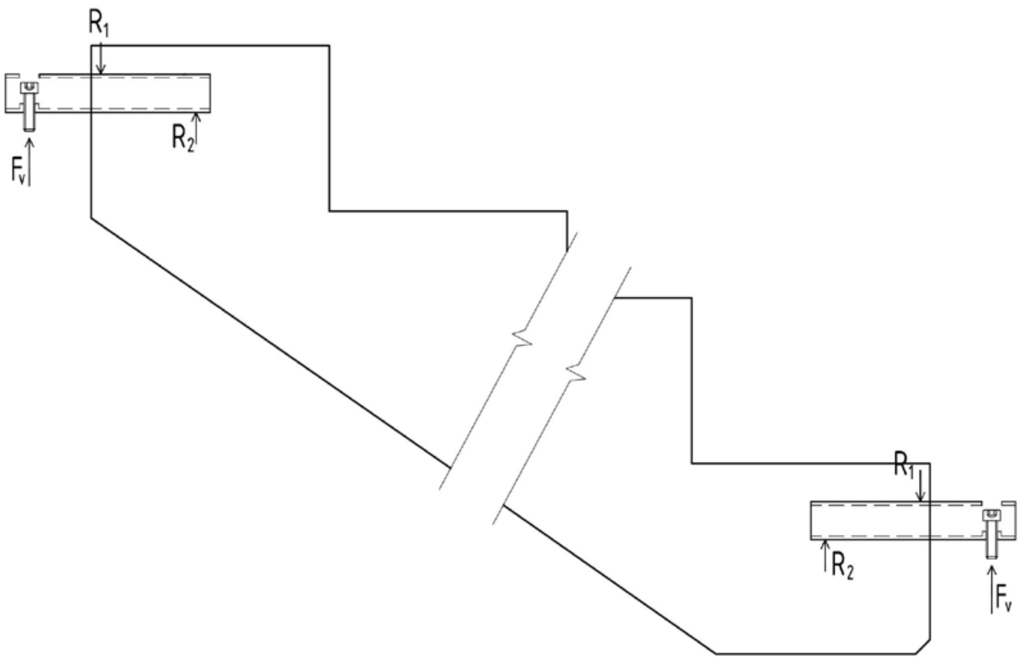

Figure 2: Forces.

Reinforcement R_1: $A_{s1} = R_1/f_{sd} = 37,8kN/435Mpa = 87\ mm^2$
Select 1-Ø10 = 2×78 mm^2 =156 mm^2
Capacity selected reinforcement: R=156 $mm^2 \cdot 435MPa=67,8kN$

Reinforcement R_2: $A_{s2} = R_2/f_{sd} = 17,8kN/435MPa = 41\ mm^2$
Select 1-Ø8 = 1×2×50 mm^2 = 100mm^2
Capacity selected reinforcement: R=100 $mm^2 \cdot 435MPa=43,5kN$

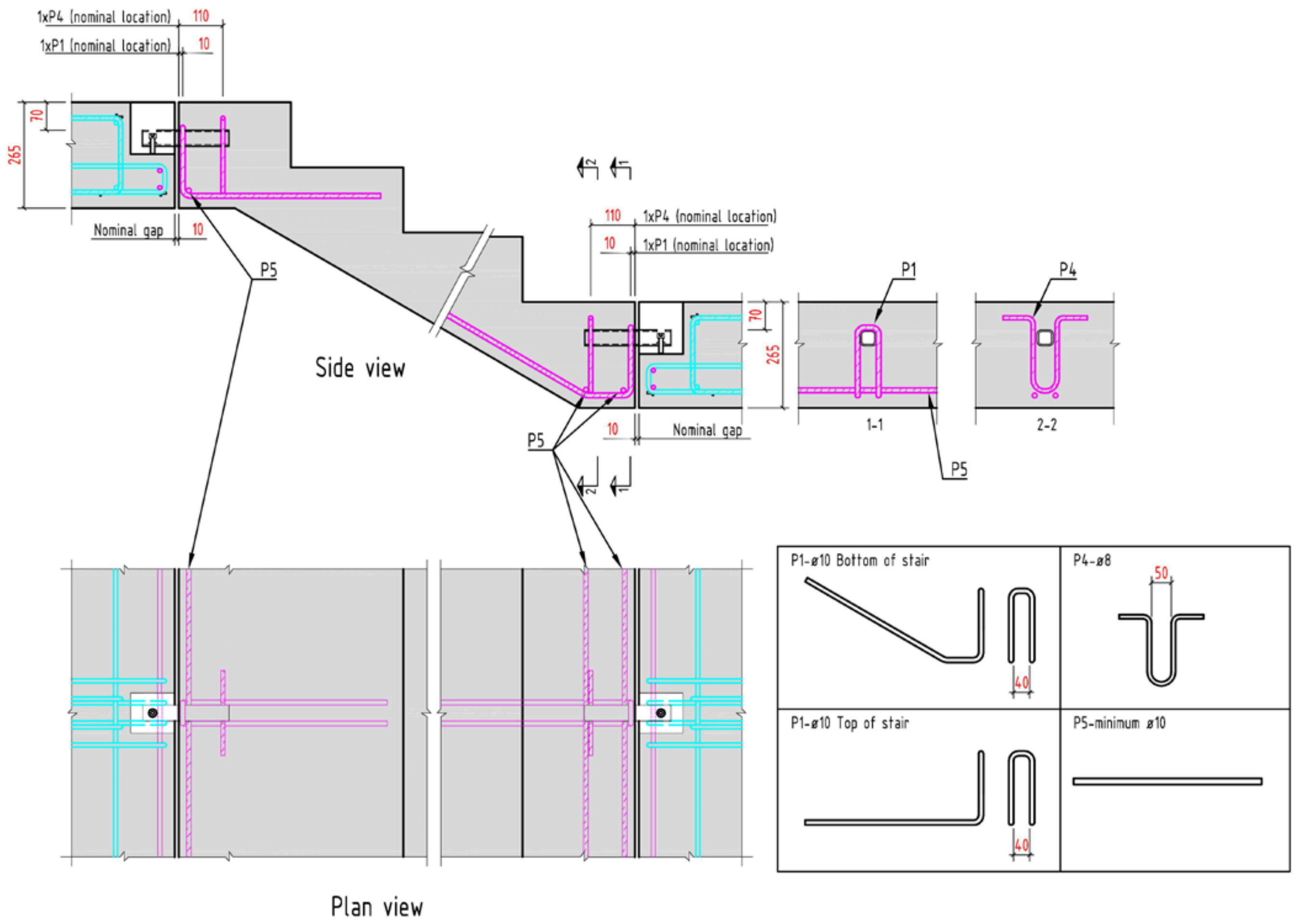

Figure 3: Anchoring reinforcement in stair.

Note:

- The P5 bars is to be located in the bends of the P1 bar.

Tolerances on the positioning of the reinforcement:

- The assembling tolerances for P1 and P4 should be ±5mm.

PART 3 – EXAMPLE: LOCAL REINFORCEMENT AROUND RECESS IN LANDING

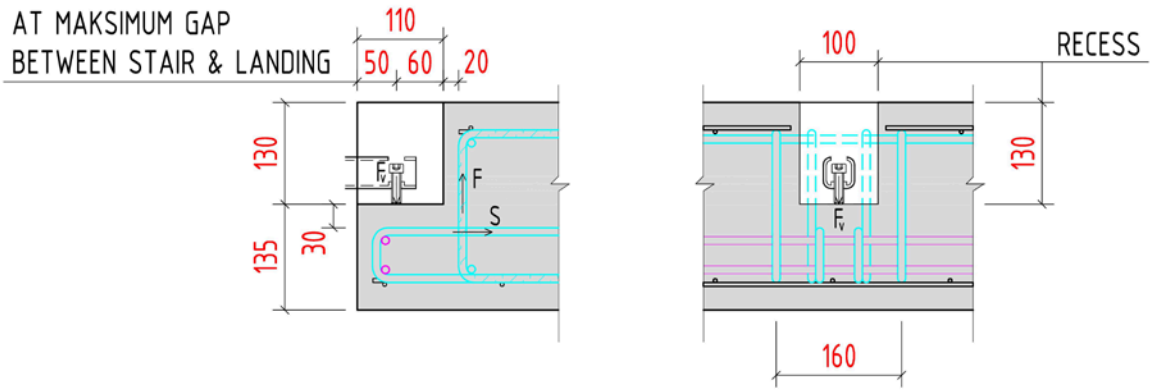

Figure 4: Forces acting on the landing.

Reinforcement below the recess:

$$A_s = \frac{S}{f_{sd}} = \frac{\dfrac{F_v \cdot (60mm + 20mm + 5mm)}{z}}{f_{sd}} = \frac{\dfrac{F_v \cdot (60mm + 20mm + 5mm)}{0{,}8 \cdot (135mm - 30mm - 5mm)}}{f_{sd}} = \frac{\dfrac{20000N \cdot 85mm}{80mm}}{435MPa} = 49mm^2$$

Select 2-Ø8 stirrups = 100 mm²
Capacity selected reinforcement: R=100mm² ·435MPa=43,5kN

Reinforcement behind the recess:

$$A_s = \frac{F}{f_{sd}} = \frac{20kN}{435MPa} = 46mm^2$$

Select 2-Ø8 stirrups = 100 mm²
Capacity selected reinforcement: R=100mm² ·435MPa=43,5kN

Reinforcement at the sides of the recess:

$$A_s = \frac{F}{f_{sd}} = \frac{20kN}{435MPa} = 46mm^2$$

Select 1-Ø8 stirrup at each side = totally 100 mm²
Capacity selected reinforcement: R=100mm² ·435MPa=43,5kN

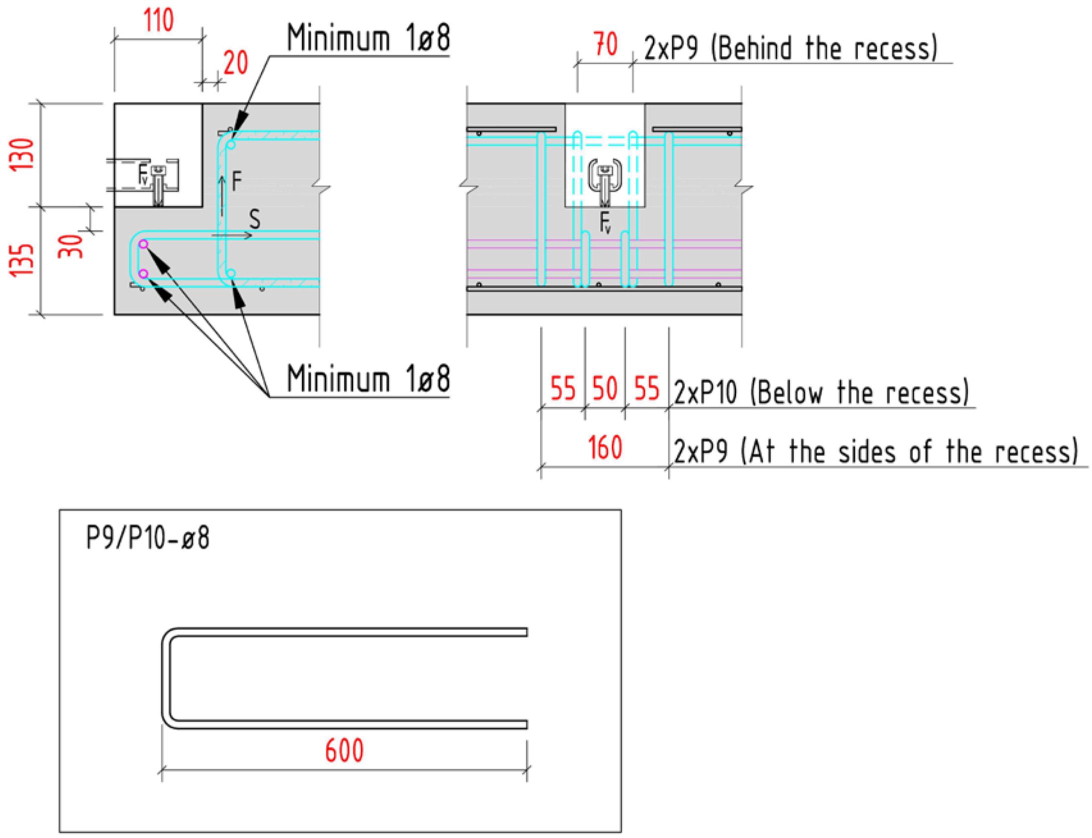

Figure 5: Possible local reinforcement in landing t=265mm.

If the landing is too thin to have reinforcement below the recess (-P10), a wide steel plate may be introduced. This steel plate should be thick enough to receive the load from the M12 bolt and transfer it sideways into the supporting P9 bars at the sides of the recess.

REVISION HISTORY	
Date:	**Description:**
10.04.2015	First edition.
08.01.2016	Included note on reinforcement ductility grade.
25.05.2016	New template.