MINIMUM REINF.

$$A_{s,min} = 0.26 \frac{f_{ctm}}{f_{yk}} b_t d = 0.26 \frac{2.9}{500} 400 \cdot 550 = 332 \text{ mm}^2$$

$$A_{s,min} = 0.0013 b_t d = 0.0013 \cdot 400 \cdot 550 = 286 \text{ mm}^2$$

$d = h - c_{nom} - \phi_s - \phi/2 = 600 - 30 - 10 - 20/2 = 550$ mm — EFFECTIVE HEIGHT

$A_{s,min} = \max(332, 286) = 332 \text{ mm}^2$ — MINIMUM REINFORCEMENT

[PN-EN 1992-1-1, p. 9.2.1.1]

SINGLY REINFORCED SECTION

$$S_c = \frac{M_{Ed}}{f_{cd} \cdot b \cdot d^2} = \frac{200 \cdot 10^6}{17 \cdot 400 \cdot 550^2} = 0,0372$$

$$\zeta_{eff} = 1 - \sqrt{1 - 2S_c} = 1 - \sqrt{1 - 2 \cdot 0,0372} = 0,1025$$ — HEIGHT OF COMPRESSION ZONE

$$\zeta_{eff,lim} = 0.8 \cdot \frac{0.0035}{0.0035 + \frac{f_{yd}}{E_s}} = 0.8 \frac{0,0035}{0.0035 + \frac{434.78}{200\,000}} = 0.493$$

$\zeta_{eff} = 0.1025 \leq \zeta_{eff,lim} = 0.493$ — HEIGHT OF COMPRESSION ZONE SMALLER THAN LIMITING HEIGHT OF COMPRESSION ZONE – SINGLY REINFORCED SECTION

$$A_{s,1} = \frac{f_{cd} \cdot b \cdot \zeta_{eff} \cdot d}{f_{yd}} = \frac{17 \cdot 400 \cdot 0.1025 \cdot 550}{434.78} = 882 \text{ mm}^2$$

REQUIRED REINFORCEMENT

$A_{s,1} > A_{s,min} = 332 \text{ mm}^2 \Rightarrow$ ASSUME $A_{s,req} = 882 \text{ mm}^2$

	12	16	20	25	32
1	113	201	314	491	804
2	226	402	628	982	1608
3	339	603	942	1473	2413
4	452	804	1257	1963	3217
5	565	1005	1571	2454	4021

OK

ASSUMED REINFORCEMENT : 3 ϕ20 – VERIFY SPACING REQUIREMENTS