Specific rules for design and detailing of concrete buildings
Design for DCM and DCH
Illustration of elements design

M.N. Fardis
University of Patras (GR)

G. Tsionis
University of Patras (GR)

Structure of EN1998-1:2004

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Design concepts for safety under design seismic action

1. Design for energy dissipation (via ductility): $q>1.5$
   - **Global ductility:**
     - Structure forced to remain straight in elevation through shear walls or strong columns ($\Sigma M_{Rc}>1.3\Sigma M_{Rb}$ in frames):
   - **Local ductility**:
     - Plastic hinges detailed for ductility capacity derived from q-factor;
     - Brittle failures prevented by overdesign/capacity design
   - **Capacity design of foundations & foundation elements**:
     - On the basis of overstrength of ductile elements of superstructure.

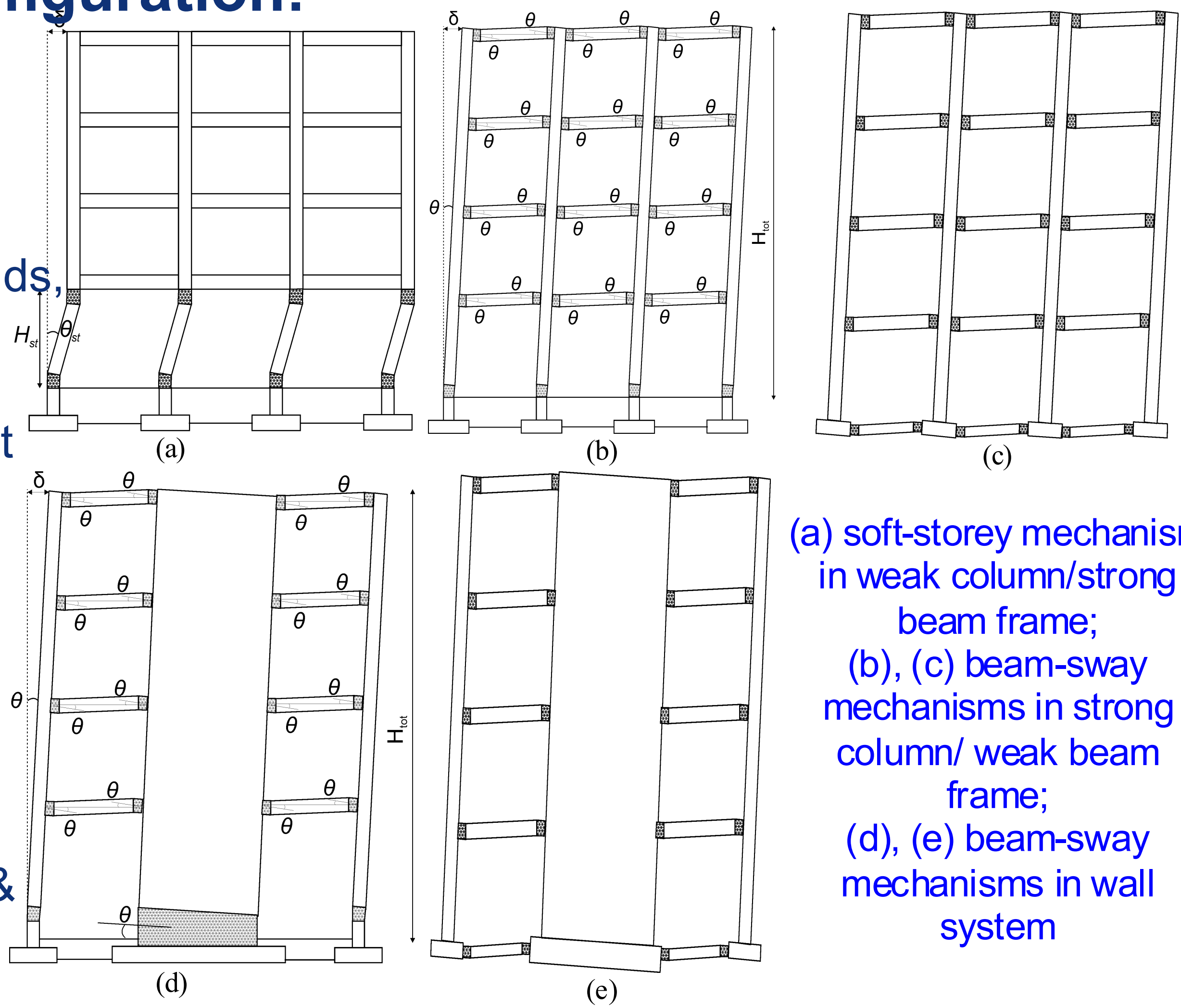
   (Or: Foundation elements - incl. piles - designed & detailed for ductility)
2. Design w/o energy dissipation & ductility: $q\leq1.5$ for overstrength; design only according to EC2 & EC7 (Ductility Class “Low”– DCL) Only:
   - for Low Seismicity (NDP; recommended: PGA on rock ≤0.08g)
   - for superstructure of base-isolated buildings.

Control of inelastic seismic response

Soft-storey collapse mechanism to be avoided through proper structural configuration:

•Strong-column/weak beam frames, with beam-sway mechanisms, involving:
- plastic hinging at all beam ends, and
- either plastic hinging at column bottoms, or rotations at the foundation.

• Wall-equivalent dual frames, with beam-sway mechanism, involving:
- plastic hinging at all beam ends, and
- either plastic hinging at wall & column bottoms, or rotations at the foundation.



(a) soft-storey mechanism in weak column/strong beam frame;
(b), (c) beam-sway mechanisms in strong column/ weak beam frame;
(d), (e) beam-sway mechanisms in wall system

1. Damage limitation (storey drift ratio < 0.5-1%) under the damage limitation earthquake (~50% of "design seismic action"), using 50% of uncracked gross section stiffness.
2. Member verification for the Ultimate Limit State (ULS) in bending under the "design seismic action", with elastic spectrum reduced by the behaviour factor *q*.
3. In frames or frame-equivalent dual systems: Meet strong column/weak beam capacity design rule, with overstrength factor of 1.3 on beam strengths.
4. Capacity design of members (and joints) in shear.
5. Detailing of plastic hinge regions, on the basis of the value of the curvature ductility factor that corresponds to the q-factor value.

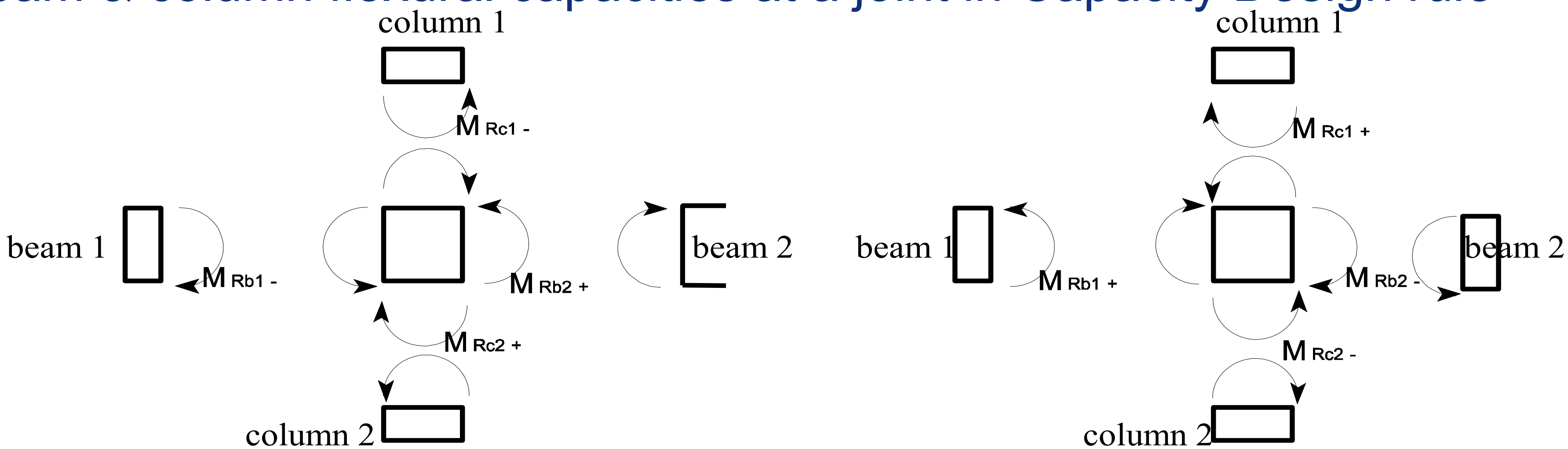
Column capacity design rule in frames

Fulfilment of strong column/weak beam capacity design rule, with overstrength factor γ_{Rd} on beam strengths:

$$\Sigma M_{Rc} \geq \gamma_{Rd} \Sigma M_{Rb}$$

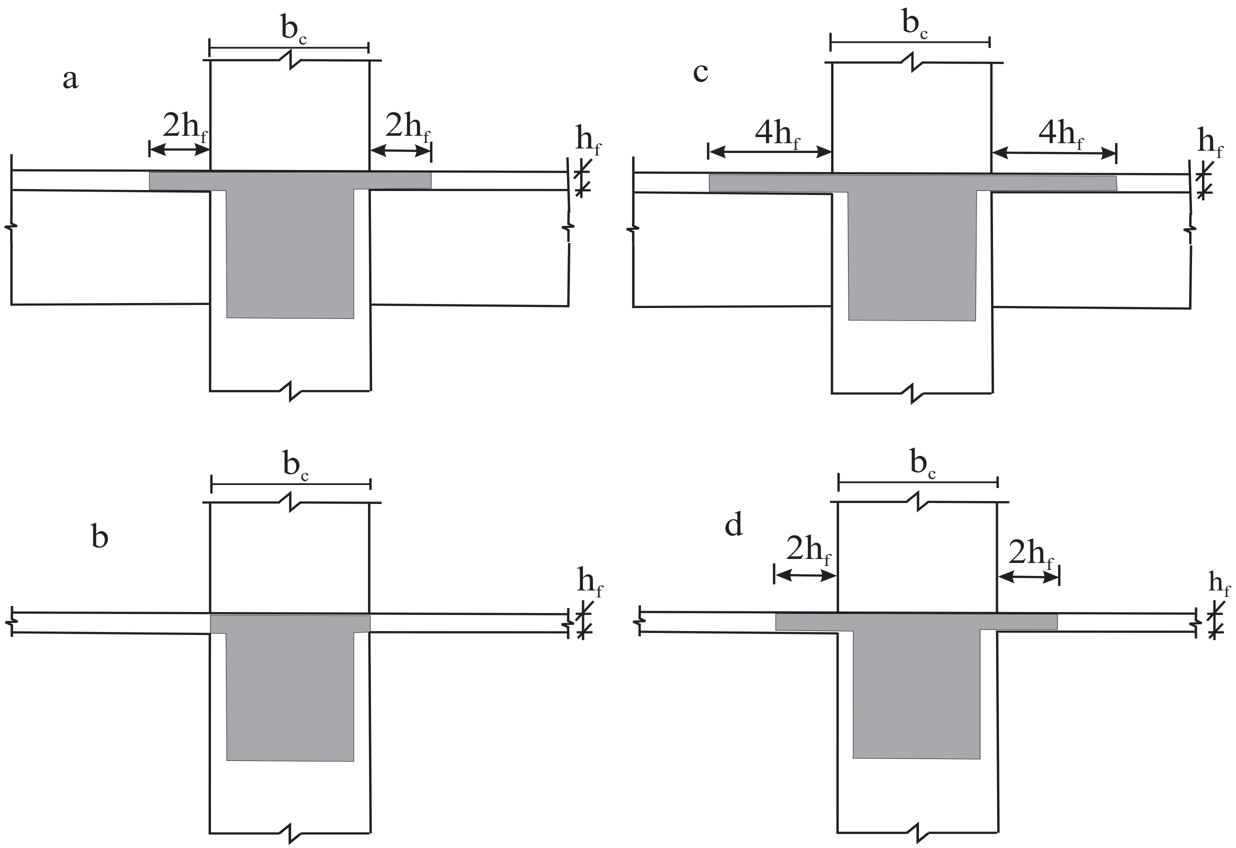
Eurocode 8: γ_{Rd} = 1.3; strong column/weak beam capacity design required only in frames or frame-equivalent dual systems (: frames resist >50% of seismic base shear) above two storeys (except at top storey joints).

Beam & column flexural capacities at a joint in Capacity Design rule



For the calculation of M_{Rb}:

Width of slab effective as tension flange of beams at the support to a column:



a, b: at exterior column; c, d: at interior column: small – is it safe for capacity design?

NDP-partial factors for materials, in ULS verifications:

- **Recommended: use same values as for persistent & transient design situations (i.e. in concrete buildings: γ_c=1.5, γ_s=1.15);**

Seismic design of the foundation

- Objective: The ground and the foundation system should not reach its ULS before the superstructure, i.e. should remain elastic while inelasticity develops in the superstructure.
- Means:
  - The ground and the foundation system are designed for their ULS under seismic action effects from the analysis derived for q=1.5, i.e. lower than the q-value used for the design of the superstructure; or
  - The ground and the foundation system are designed for their ULS under seismic action effects from the analysis multiplied by $\gamma_{Rd}(R_{di}/E_{di}) \leq q$, where R_{di} force capacity in the dissipative zone or element controlling the seismic action effect of interest, E_{di} the seismic action effect there from the elastic analysis and γ_{Rd}=1.2 (γ_{Rd}=1.0 if $q \leq 3.0$)
  - For individual spread footings of walls or columns of moment-resisting frames, R_{di}/E_{di} is the minimum value of M_{Rd}/M_{Ed} in the two orthogonal principal directions at the lowest cross-section of the vertical element where a plastic hinge can form in the seismic design situation;
  - For common foundations of more than one elements, $\gamma_{Rd}(R_{di}/E_{di})$ =1.4.

Frame, wall, or dual systems in RC buildings

- **Eurocode 8 definitions:**
  - Frame system: Frames take >65% of seismic base shear, V_{base}
  - Wall system: Walls take > 65% of V_{base}.
  - Dual system: Walls and frames take between 35 % & 65% of V_{base} each.
  - Frame-equivalent dual system: Frames take between 50 % & 65% of V_{base}.
  - Wall-equivalent dual system: Walls take between 50 % & 65% of V_{base}.

- **Eurocode 2 definition of wall: Wall ≠ column in that its cross-section is elongated (l_w/b_w>4)**

For Dissipative Structures:

Two Ductility Classes (DC):

– DC H (High)

– DC M (Medium).

Differences in:

– q-values (q > 4 for DCH, 1.5 <q <4 for DCM)

– Local ductility requirements

(ductility of materials, member detailing, capacity design against brittle failure modes)

- **Ductility Classes (DC)**
  - Design based on energy dissipation and ductility:
    - DC (M) Medium q = 3 x system overstrength factor (≈1.3).
    - DC (H) High q= 4-4.5 x system overstrength factor (≈ 1.3).
  - The aim of the design is to control the **inelastic seismic response**:
  - Structural configuration & relative sizing of members to ensure a beam-sway mechanism.
  - Detailing of plastic hinge regions (beam ends, base of columns) to sustain inelastic deformation demands.
  - Plastic hinge regions are detailed for **deformation demands** related to **behaviour factor q**:
  - $\mu_\delta = q$ if $T > T_c$
  - $\mu_\delta = 1 + (q-1) T_c / T$ if $T \leq T_c$

Material limitations for “primary seismic elements”

Ductility Class	**DC L (Low)**	**DC M (Medium)**	**DC H (High)**
Concrete grade	No limit	≥ C16/20	≥ C16/20
Steel class per EN 1992-1-1, Table C1	B or C	B or C	only C
Longitudinal bars		only ribbed	only ribbed
Steel overstrength:	No limit	No limit	$f_{yk,0.95} \leq 1.25 f_{yk}$

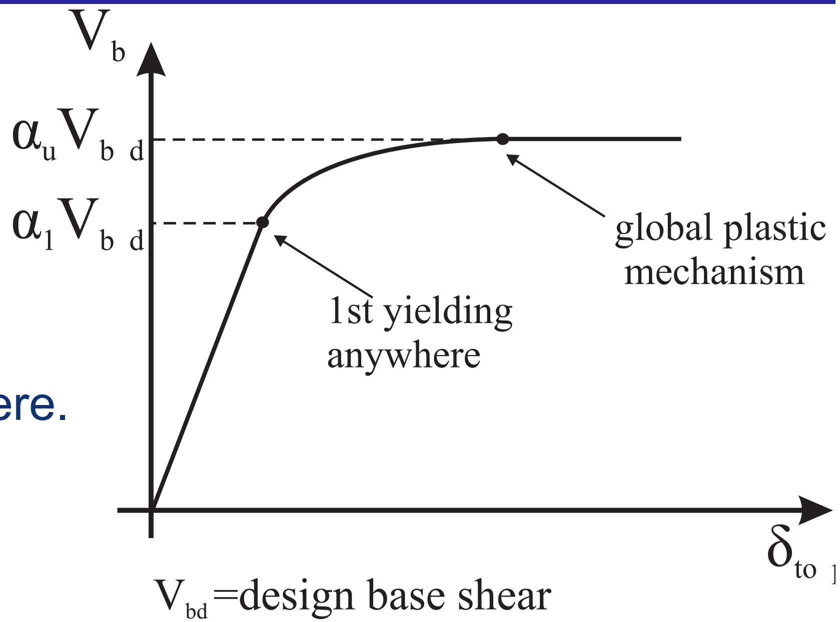
Basic value, q_o, of behaviour factor for regular in elevation concrete buildings in Eurocode 8

Lateral-load resisting structural system	DC M	DC H
Inverted pendulum system*	1.5	2
Torsionally flexible structural system**	2	3
Uncoupled wall system (> 65% of seismic base shear resisted by walls; more than half by uncoupled walls) not belonging in one of the categories above	3	$4\alpha_u/\alpha_1$
Any structural system other than those above	$3\alpha_u/\alpha_1$	$4.5\alpha_u/\alpha_1$

* at least 50% of total mass is in upper-third of the height, or all energy dissipation takes place at the base of a single element (except one-storey frames w/ all columns connected at the top via beams in both horizontal directions in plan & with max. value of normalized axial load in seismic design situation $v_d \leq 0.3$).
** at any floor: radius of gyration of floor mass > torsional radius in one or both main horizontal directions (sensitive to torsional response about vertical axis).

- Buildings irregular in elevation: behaviour factor **$q = 0.8q_o$**;
- Wall or wall-equivalent dual systems: q multiplied (further) by $(1+a_o)/3 \leq 1$, (a_o: prevailing wall aspect ratio = $\Sigma H_i/\Sigma l_{wi}$).

α_u/α_1 in behaviour factor of buildings designed for ductility: due to system redundancy & overstrength



Normally:

α_u & α_1 from base shear-top displacement curve of a pushover analysis.

- α_u: seismic action at development of global mechanism;
- α_1 : seismic action at 1st flexural yielding anywhere.
- $\alpha_u / \alpha_1 \leq 1.5$;
- default values given between 1 to 1.3 for buildings regular in plan:

= 1.0 for wall systems w/ just 2 uncoupled walls per horiz. direction;

= 1.1 for: one-storey frame or frame-equivalent dual systems, or wall systems w/ > 2 uncoupled walls per direction;

= 1.2 for: (one-bay multi-storey frame or frame-equivalent dual systems), wall-equivalent dual systems or coupled wall systems;

= 1.3 for: multi-storey multi-bay frame or frame-equivalent dual systems.

- for buildings irregular in plan:

default value = average of default value of buildings regular in plan and 1.0

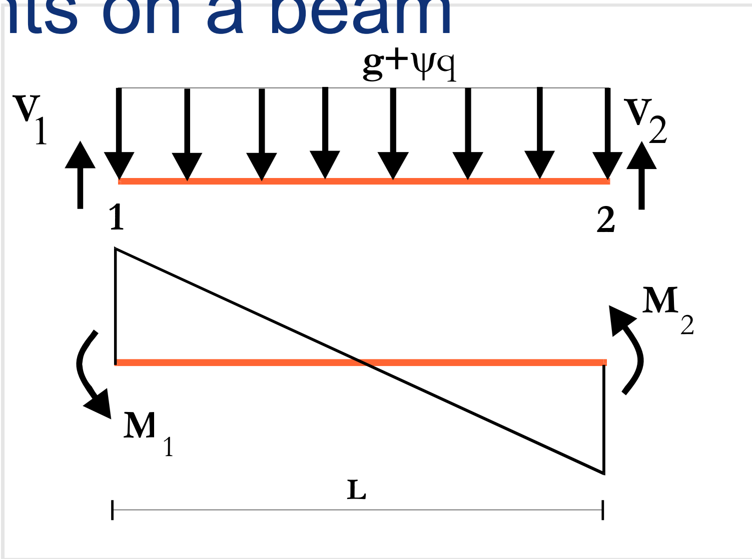
Capacity design of members, against pre-emptive shear failure

I. Beams

Equilibrium of forces and moments on a beam

$$V_1 = V_{g+\psi q,1} + \frac{M_2 + M_1}{l_{cl}}$$

$$V_2 = V_{g+\psi q,2} - \frac{M_1 + M_2}{l_{cl}}$$

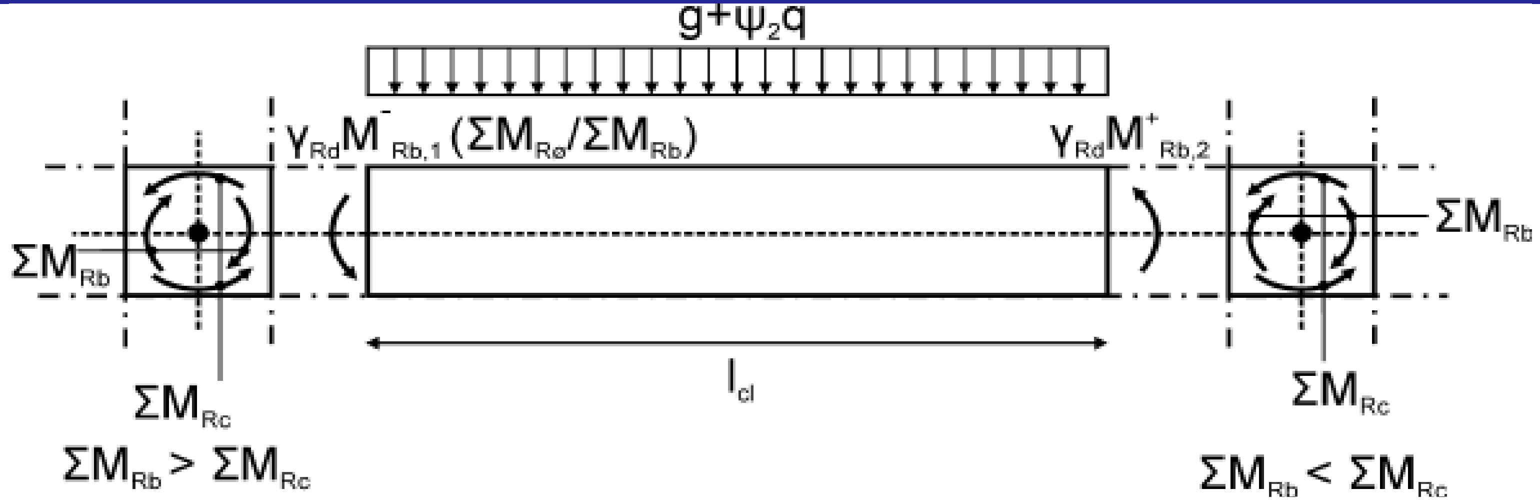


Capacity-design shear in a beam weaker than the columns:

$$V_{CD,1} = V_{g+\psi q,1} + \gamma_{Rd} \frac{M^{-}_{Rd,b1} + M^{+}_{Rd,b2}}{l_{cl}}$$

$$V_{CD,2} = V_{g+\psi q,2} + \gamma_{Rd} \frac{M^{+}_{Rd,b1} + M^{-}_{Rd,b2}}{l_{cl}}$$

Capacity-design shear in beams (weak or strong) - Eurocode 8



$$\max V_{i,d}(x) = \frac{\gamma_{Rd}\left[M_{Rd,bi}^{-} \min\left(1; \frac{\sum M_{Rd,c}}{\sum M_{Rd,b}}\right)_i + M_{Rd,bj}^{+} \min\left(1; \frac{\sum M_{Rd,c}}{\sum M_{Rd,b}}\right)_j \right]}{l_{cl}} + V_{g+\psi_2 q,o}(x)$$

$$\min V_{i,d}(x) = -\frac{\gamma_{Rd}\left[M_{Rd,bi}^{+} \min\left(1; \frac{\sum M_{Rd,c}}{\sum M_{Rd,b}}\right)_i + M_{Rd,bj}^{-} \min\left(1; \frac{\sum M_{Rd,c}}{\sum M_{Rd,b}}\right)_j \right]}{l_{cl}} + V_{g+\psi_2 q,o}(x)$$

Eurocode 8:

- in DC M $\gamma_{Rd}=1.0$,
- in DC H $\gamma_{Rd}=1.2$ & reversal of V accounted for, depending on: $\zeta_i = \frac{\min V_{i,d}(x_i)}{\max V_{i,d}(x_i)}$

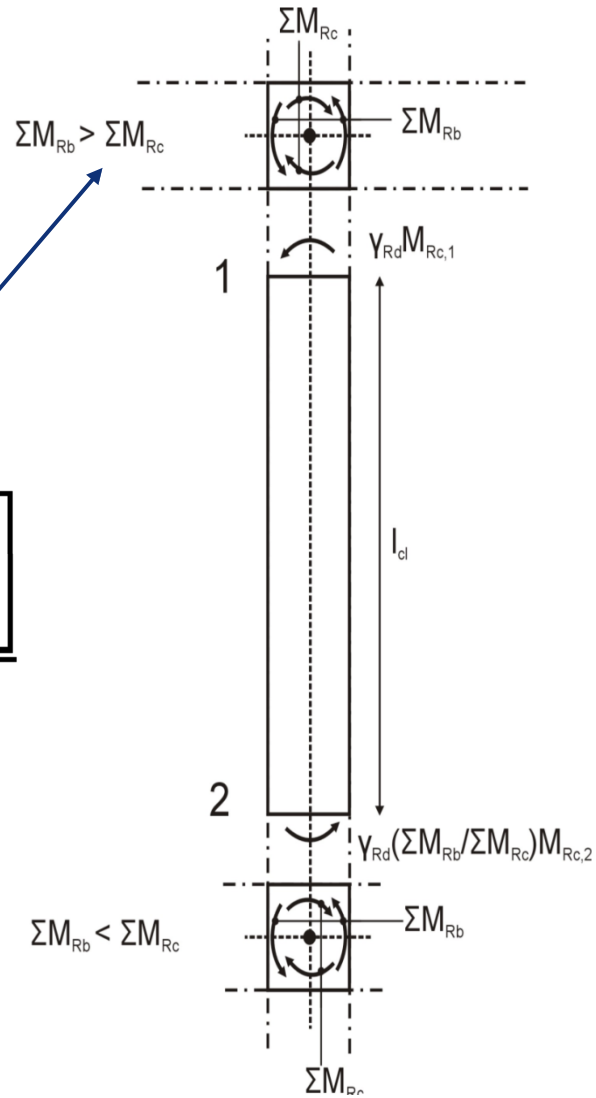
II. Columns

Capacity-design shear in column which is weaker than the beams:

$$V_{CD}^{+}=\gamma_{Rd}\frac{M_{Rd,c1}^{+}+M_{Rd,c2}^{-}}{h_{cl}} \quad V_{CD}^{-}=\gamma_{Rd}\frac{M_{Rd,c1}^{-}+M_{Rd,c2}^{+}}{h_{cl}}$$

Capacity-design shear in (weak or strong) columns - Eurocode 8:

$$V_{CD,c}=\frac{\gamma_{Rd}\left[M_{Rd,c1}\min\left(1;\frac{\sum M_{Rd,b}}{\sum M_{Rd,c}}\right)_1+M_{Rd,c2}\min\left(1;\frac{\sum M_{Rd,b}}{\sum M_{Rd,c}}\right)_2\right]}{h_{cl}}$$



Eurocode 8:

in DC M $\gamma_{Rd}=1.1$

in DC H $\gamma_{Rd}=1.3$

III. Walls

Eurocode 8:

Over-design in shear, by multiplying shear forces from the analysis for the design seismic action, V'_{Ed}, by factor ε:

DC M walls:

$$\varepsilon = \frac{V_{Ed}}{V'_{Ed}} = 1.5$$

DC H squat walls ($h_w/l_w \leq 2$):

$$\varepsilon = \frac{V_{Ed}}{V'_{Ed}} = \gamma_{Rd}\left(\frac{M_{Rdo}}{M_{Edo}}\right) \leq q$$

Over-design for flexural overstrength of the base w.r.to analysis

M_{Edo}: design moment at base section (from analysis),

M_{Rdo}: design flexural resistance at the base section,

$\gamma_{Rd}=1.2$

DC H slender walls ($h_w/l_w > 2$):

$$\varepsilon = \frac{V_{Ed}}{V'_{Ed}} = \sqrt{\left(\gamma_{Rd}\frac{M_{Rdo}}{M_{Edo}}\right)^2 + 0.1\left(q\frac{S_e(T_C)}{S_e(T_1)}\right)^2} \leq q$$

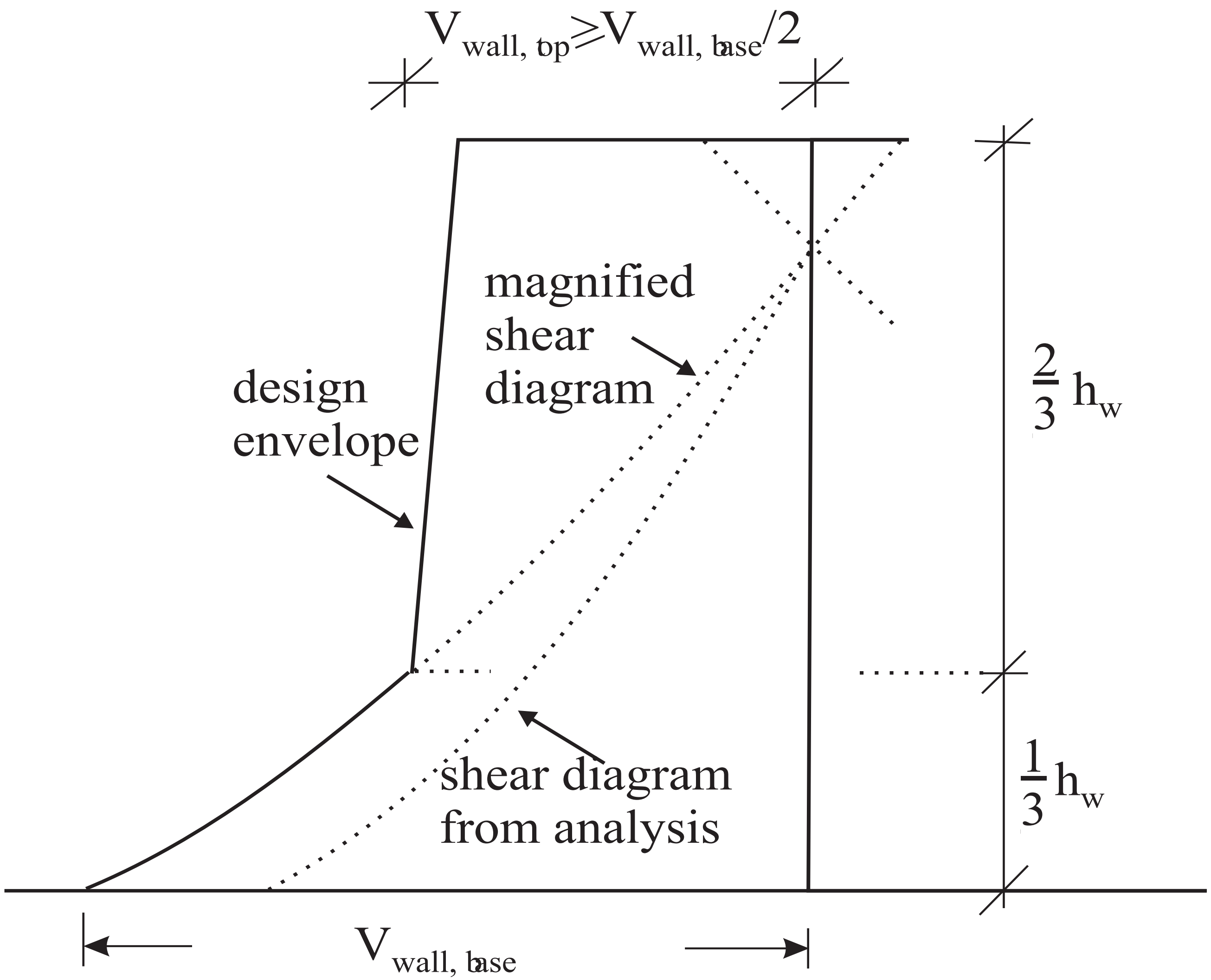
Over-design for flexural overstrength of the base w.r.to analysis & for increased inelastic shears

$S_e(T)$: ordinate of elastic response spectrum

T_C: upper limit T of const. spectral acc. region

T_1: fundamental period

Design shear forces in "dual" structural systems per Eurocode 8



To account for increase in the upper storey shears due to higher mode inelastic response (after plastic hinging at the base)

Detailing of dissipative zones (flexural plastic hinges) for curvature ductility factor μ_φ consistent w/ q-factor

- $\mu_\varphi = 2q_o - 1$ if $T_1 \geq T_c$
- $\mu_\varphi = 1 + 2(q_o - 1)T_c/T_1$ if $T_1 < T_c$
  - T_1: fundamental period of building,
  - T_c: T at upper limit of constant spectral acceleration region,
  - q_o: *q-factor* unreduced for irregularity in elevation (multiplied w/ M_{Ed}/M_{Rd} at a wall base).

- Derivation:
  - Relation between μ_φ & L_{pl}/L_s (L_{pl}: plastic hinge length, L_s: shear span) & μ_δ (: top displacement ductility factor) in buildings staying straight due to walls or strong columns: $\mu_\delta = 1 + 3(\mu_\varphi - 1)L_{pl}/L_s(1 - 0.5L_{pl}/L_s)$;
  - Relation q-μ_δ-T:

    $\mu_\delta = q$ if $T_1 \geq T_c$, $\mu_\delta = 1 + (q-1)T_c/T_1$ if $T_1 < T_c$;
  - Relation of L_{pl} & L_s for typical RC beams, columns & walls (for EC2 confinement model: $\varepsilon^*_{cu} = 0.0035 + 0.1\alpha_{\omega w}$): $L_{pl} \approx 0{,}3L_s$ & for (safety) factor 2: $L_{pl} = 0{,}15L_s$. Then: $\mu_\varphi \approx 2\mu_\delta - 1$

- For steel B (ε_u: 5-7.5%, f_t/f_y: 1.08-1.15) increase μ_φ-demand by 50%

Means for achieving μ_φ in plastic hinges

- Base region of members w/ axial load & symmetric reinforcement, $\omega=\omega'$ (columns, ductile walls):
  - Confining reinforcement (for walls: in boundary elements) with (effective) mechanical volumetric ratio:

    $$\alpha\omega_{wd} = 30\mu_\varphi(v_d+\omega_v)\varepsilon_{yd}b_c/b_o - 0.035$$

    $v_d=N_d/b_c h f_{cd}$; $\varepsilon_{yd}=fy_d/E_s$;

    b_c: width of compression zone; b_o: width of confined core;

    ω_v: mechanical ratio of longitudinal web reinforcement $=\rho_v f_{yd,v}/f_{cd}$
  - DC H columns not meeting the strong-column/weak-beam rule ($\Sigma M_{Rc}<1.3\Sigma M_{Rb}$), should have full confining reinforcement at the end regions of all storeys, not just at the (building) base;
  - DC H strong columns ($\Sigma M_{Rc}>1.3\Sigma M_{Rb}$) are also provided w/ confining reinforcement for μ_φ corresponding to 2/3 of q_o at the end regions of every storey.

- Members w/o axial load & w/ asymmetric reinforcement (beams):
  - Max. mechanical ratio of tension steel:

    $$\omega \le \omega' + 0.0018/\mu_\varphi\, \varepsilon_{yd}$$

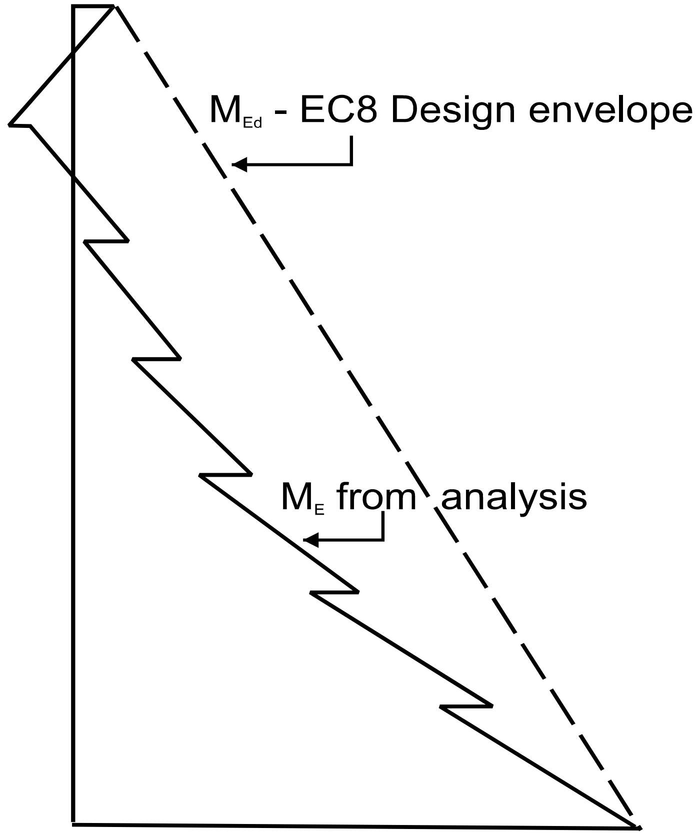
EC8 – special feature: two types of dissipative concrete walls

- Ductile walls:
  - Fixed at the base, to prevent rotation there w.r.to rest of structural system.
  - Designed & detailed to dissipate energy only in flexural plastic hinge just above the base.

- Large lightly-reinforced walls (only for DC M):
  - Walls with horizontal dimension $l_w \geq$ 4m, expected to develop limited cracking or inelastic behaviour during design seismic action, but to transform seismic energy to potential energy (uplift of masses) & to energy radiated back into the soil by rigid-body rocking, etc.
  - Due to its dimensions, or lack-of-fixity at base, or connectivity with transverse walls preventing pl. hinge rotation at base, such a wall cannot be designed for energy dissipation in pl. hinge at the base.

Ductile walls: Overdesign in bending

Strong column/weak beam capacity design is not required in wall or wall-equivalent dual systems (i.e. in those where walls resist >50% of seismic base shear)



But:
all ductile walls are designed in flexure, to ensure that plastic hinge develops only at the base:

Typical moment diagram in a concrete wall from the analysis & linear envelope for its (over-)design in flexure according Eurocode 8

Ductile walls: Design in bending & shear and detailing

- Inelastic action limited to a plastic hinge at the base, so that the cantilever relation between q & μ_{φ} applies:
  - Wall is provided with flexural overstrength above plastic hinge region (linear moment envelope with shift rule);
  - Design in shear for V from analysis, times:

  1.5 for DC M

  $[(1.2\ M_{Rd}/M_{Ed})^2+0.1(qS_e(T_c)/S_e(T_1))^2]^{1/2} < q$ for DC H

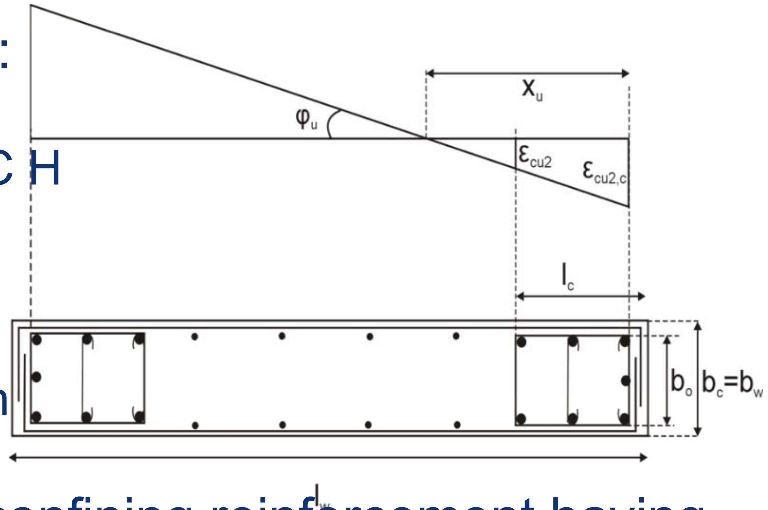
  M_{Ed}: design moment at base (from analysis),

  M_{Rd}: design flexural resistance at base,

  $S_e(T)$: ordinate of elastic response spectrum,

  T_c: upper limit T of const. spectral acc. region

  T_1: fundamental period.



- In plastic hinge zone: boundary elements w/ confining reinforcement having effective mechanical volumetric ratio:

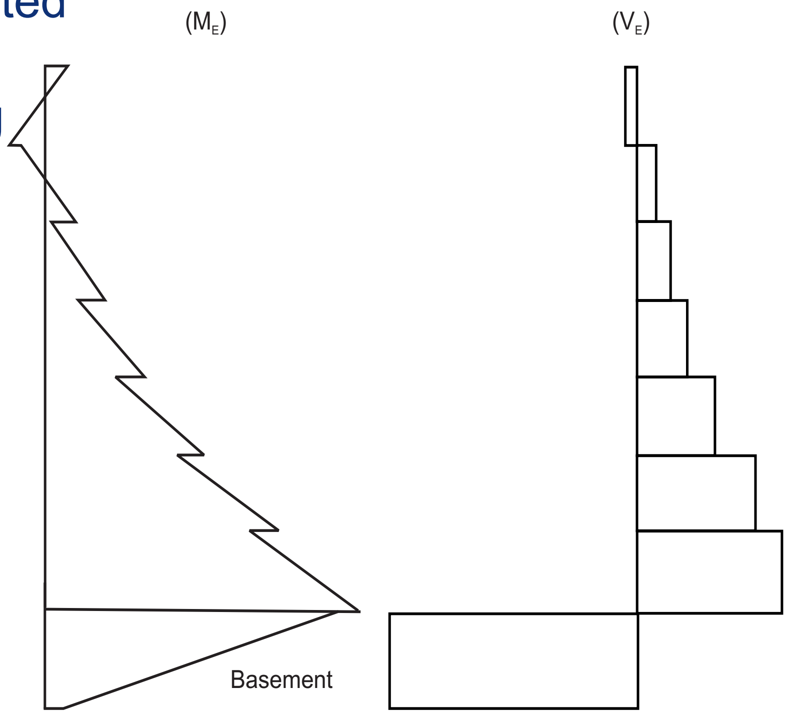
$$\alpha\omega_{wd}=30\mu_{\varphi}(v_{d}+\omega_{\square})\varepsilon_{yd}b_c/b_o-0.035$$

over at least the part of the compression zone depth: $x_u=(v_d+\omega_v)l_w\varepsilon_{yd}b_c/b_o$
where the strain is between: $\varepsilon^*_{cu}=0.0035+0.1\alpha\omega_w$ & $\varepsilon_{cu}=0.0035$

Foundation problem of ductile walls

- To form a plastic hinge at the wall base → We need fixity there:
  - Very large & heavy footing; adds own weight to *N* & does not uplift; or
  - Fixity of wall in a "box type" foundation system:

1. Wall-like deep foundation beams along entire perimeter of the foundation (possibly supplemented w/ interior ones across full length of foundation system) = main foundation elements transferring seismic action effects to the ground.
   In buildings w/ basement: perimeter foundation beams may double as basement walls.
2. Slab designed to act as rigid diaphragm, at the level of the top flange of perimeter foundation beams (e.g. basement roof).
2. Foundation slab, or two-way tie-beams or foundation beams, at the level of bottom of perimeter foundation beams.

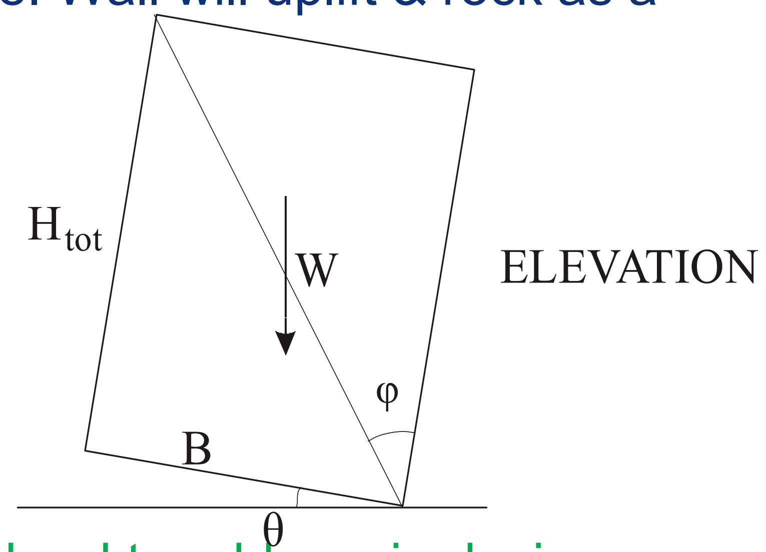


- Fixity of interior walls provided by couple of horizontal forces between 2 & 3 → High reverse shear in part of the wall within the basement

The problem of the foundation of a large wall

- Large $l_w(=h)$ →
  - large moment at the base
  - (for given axial load) low normalized axial force $v=N/(bhfc)$~0.05.
- Footing of usual size w/ tie-beams of usual size: insufficient:
  - Max normalized moment $\mu=M/(bh^2f_{cd})$ that can be transferred to the ground:
  - μ ~0.5v, i.e. ~wall cracking moment! →

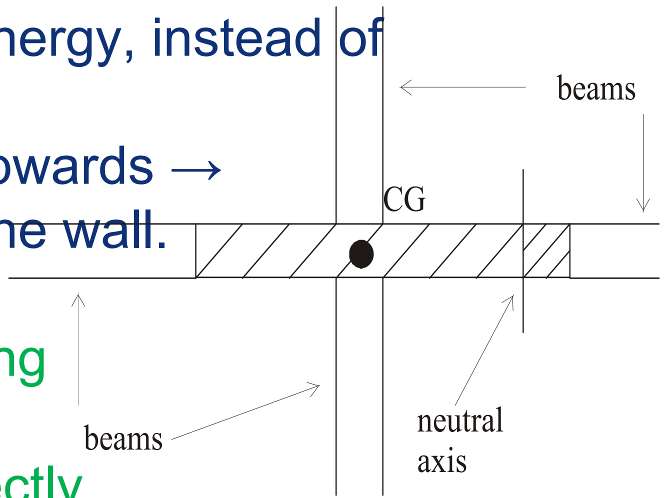
Impossible to form plastic hinge at the wall base. Wall will uplift & rock as a rigid body.



~Rigid large walls on large footing:
Rocking → radiation damping in the soil.
Rotation of rocking wall:
$\theta \sim S_v^2/Bg << \varphi=\arctan(B/H_{tot})$ →
Very stable nonlinear-elastic behaviour; but hard to address in design

Geometric effects in large walls, due to rocking or plastic hinging

- Rotation of uplifting/rocking wall takes place about a point close to the toe of its footing.
- Rotation at a wall plastic hinge at the base takes place about a neutral axis which is close to the edge of the wall section.
- In both cases the centroid of the wall section is raised at every rotation:
  - Centre of Gravity (CG) of masses supported by the wall is raised too → (temporary) harmless increase in potential energy, instead of damaging deformation energy;
  - Ends of beams framing into the wall move upwards → beam moments & shears are stabilizing for the wall.



Plan view: beams framing into wall

- Wall responds as a "stack" of rigid blocks, uplifting at the base & at hor. sections that crack & yield (storey bottom). The favourable effects are indirectly taken into account in design

→ *q*-factor

Examples of large walls

Large lightly reinforced concrete walls

- Wall system classified as one of large lightly reinforced walls if, in horizontal direction of interest:
  - At least 2 walls with l_w>4 m, supporting together >20% of gravity load above (: sufficient no. of walls / floor area & significant uplift of masses); if just one wall: q=2
  - Fund. period T_1<0.5 s for fixity at the base against rotation (: low wall aspect ratio)
- Systems of large lightly reinforced walls:
  - only DC M (q=3);
  - special (less demanding) dimensioning & detailing.
- Rationale: For large walls, minimum reinforcement of ductile walls implies:
  - very high cost;
  - flexural overstrength that cannot be transmitted to ground.

  On the other hand, large lightly reinforced walls:
  - preclude (collapse due to) storey mechanism,
  - minimize nonstructural damage,
  - have shown satisfactory performance in strong EQs.
- If structural system does not qualify as one of large lightly reinforced walls, all its walls designed & detailed as ductile walls.

Design & detailing of large lightly reinforced walls in EC8

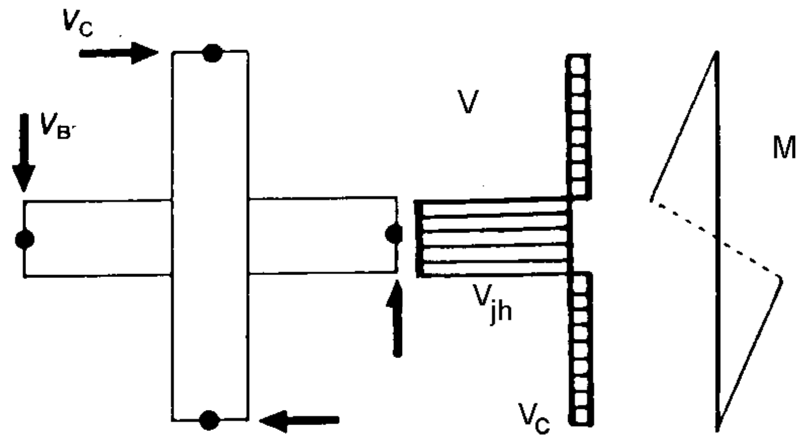
- Vertical steel tailored to demands due to *M* & *N* from analysis
  - Little excess (minimum) reinforcement, in order to minimise flexural overstrength.

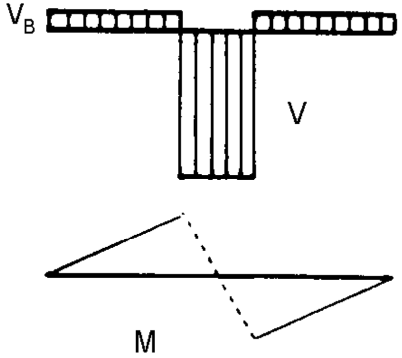
- Shear verification for *V* from analysis times $(1+q)/2$ ~2:
  - If so-amplified shear demand is less than (design) shear resistance w/o shear reinforcement:

  No (minimum) horizontal reinforcement. Reason:
    - Inclined cracking prevented (horizontal cracking & yielding due to flexure mainly at construction joints);
    - If inclined cracking occurs, crack width limited by deformation-controlled nature of response (vs. force-controlled non-seismic actions covered in EC2), even w/o min horizontal steel.

BEAM-COLUMN JOINTS IN DC H FRAMES

Shear forces in joints





max possible joint shear force & stress

If $\Sigma M_{Rb} < \Sigma M_{Rc}$:

Shear forces within joint

$$V_{jh} = (A_{sb1} + A_{sb2}) f_y - V_C = \sum M_{Rb} \left(\frac{1}{z_b} - \frac{1}{h_{st}} \frac{L_b}{L_{bn}} \right)$$

$$\approx (A_{sb1} + A_{sb2}) f_y \left(1 - \frac{z_b}{h_{st}} \frac{L_b}{L_{bn}} \right)$$

$$v_j = \frac{V_{jh}}{b_j h_{jc}}$$

If $b_c > b_w \rightarrow$ $b_j = \min \{b_c; (b_w + 0.5h_c)\}$

If $b_c \leq b_w \rightarrow$ $b_j = \min \{b_w; (b_c + 0.5h_c)\}$

Shear failures of exterior beam-column joints

Left & right: reinforced joints; centre: unreinforced joint

Principal stress approach for joint shear strength

Diagonal cracking of **unreinforced** joint if principal tensile stress due to:

- joint shear stress, v_j &
- mean vertical compressive stress from column above, $v_{top} f_c$,

exceeds concrete tensile strength, f_{ct}.

$$v_j < v_{ju} = n f_c \sqrt{1 - \frac{v_{top}}{n}}$$

Eurocode 8: Diagonal cracking of **reinforced** joint if the principal tensile stress due to:

- the joint shear stress, v_j &
- the mean vertical compressive stress from column above, $v_{top} f_c$, and
- the horizontal confining stress due to horiz. joint reinforcement, $-\rho_{jh} f_{yw}$:

exceeds the concrete tensile strength, f_{ct}.

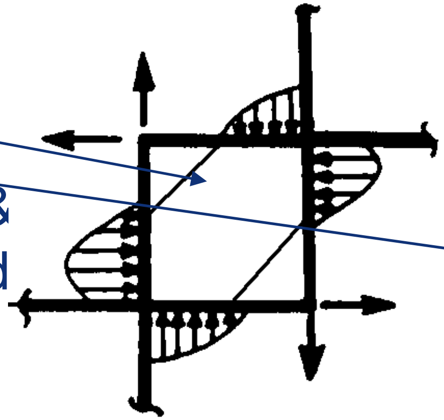
$$\rho_{jh} f_{yw} \geq \frac{v_j^2}{f_{ct} + v_{top} f_c} - f_{ct}$$

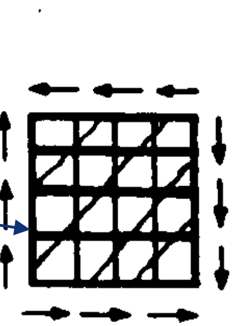
- Joint ultimate shear stress v_{ju} : if nf_c (n: reduction due to transverse tensile strain) reached in principal stress direction:

$$v_j \geq v_{cr} = f_{ct} \sqrt{1 + \frac{v_{top} f_c}{f_{ct}}}$$

Alternative approach in EC 8 for joint reinforcement

Diagonal strut
Truss of:
horizontal & vertical bars &
diagonal compressive field





Interior joints:

$$A_{sh} f_{yw} \geq (A_{sb1} + A_{sb2}) f_y \left(1 - \frac{6}{5}\nu\right)$$

Exterior joints:

$$A_{sh} f_{yw} \geq A_{sb2} f_y \left(1 - \frac{6}{5}\nu\right)$$

OVERVIEW OF DETAILING & DIMENSIONING OF PRIMARY BEAMS, COLUMNS & DUCTILE WALLS IN RC BUILDINGS OF DC H, M or L

Detailing/dimensioning of primary seismic beams (secondary ones: as in DCL)

	DC H	DCM	DCL
“critical region” length	$1.5h_w$	h_w	
Longitudinal bars (L):			
ρ_{min}, tension side	$0.5f_{ctm}/f_{yk}$		$0.26f_{ctm}/f_{yk}$, $0.13\%^{(0)}$
ρ_{max}, critical regions[1]	$\rho'+0.0018f_{cd}/(\mu_\phi \varepsilon_{sy,d} f_{yd})^{(1)}$		0.04
$A_{s,min}$, top & bottom	$2\Phi14$ ($308mm^2$)	-	
$A_{s,min}$, top-span	$A_{s,top-supports}/4$	-	
$A_{s,min}$, critical regions bottom	$0.5A_{s,top}^{(2)}$		-
$A_{s,min}$, supports bottom	$A_{s,bottom-span}/4^{(0)}$		
d_{bL}/h_c - bar crossing interior joint[3]	$\leq \frac{6.25(1+0.8\nu_d)}{(1+0.75\frac{\rho'}{\rho_{max}})}\frac{f_{ctm}}{f_{yd}}$	$\leq \frac{7.5(1+0.8\nu_d)}{(1+0.5\frac{\rho'}{\rho_{max}})}\frac{f_{ctm}}{f_{yd}}$	-
d_{bL}/h_c - bar anchored at exterior joint[3]	$\leq 6.25(1+0.8\nu_d)\frac{f_{ctm}}{f_{yd}}$	$\leq 7.5(1+0.8\nu_d)\frac{f_{ctm}}{f_{yd}}$	-

(0) NDP (Nationally Determined Parameter) per EC2. Table gives the EC2 recommended value.

(1) μ_ϕ: value of the curvature ductility factor corresponding to the basic value, q_o, of the behaviour factor used in the design

(2) The minimum area of bottom steel, $A_{s,min}$, is in addition to any compression steel that may be needed for the verification of the end section for the ULS in bending under the (absolutely) maximum negative moment from the analysis for the seismic design situation, M_{Ed}.

(3) h_c: column depth in the direction of the bar, $\nu_d = N_{Ed}/A_c f_{cd}$: column axial load ratio for the algebraically minimum axial load in the seismic design situation (compression: positive).

Detailing & dimensioning of primary seismic beams *(cont'd)*

	DC H	DCM	DCL
Transverse bars (w):			
(i) outside critical regions			
spacing $s_w \leq$	0.75d		
$\rho_w \geq$	$0.08\sqrt{(f_{ck}(MPa)}/f_{yk}(MPa)^{(0)}$		
(ii) in critical regions:			
$d_{bw} \geq$	6mm		
spacing $s_w \leq$	$6d_{bL}$, $\frac{h_w}{4}$, $24d_{bw}$, 175mm	$8d_{bL}$, $\frac{h_w}{4}$, $24d_{bw}$, 225mm	-

Detailing & dimensioning of primary seismic beams *(cont'd)*

	DC H	DCM	DCL
Shear design:			
V_{Ed}, seismic(4)	$1.2\frac{\sum M_{Rb}}{l_{cl}} \pm V_{o,g+\psi_2 q}$ (4)	$\frac{\sum M_{Rb}}{l_{cl}} \pm V_{o,g+\psi_2 q}$ (4)	from analysis for design seismic action plus gravity
$V_{Rd,max}$ seismic (5)	As in EC2: $V_{Rd,max}=0.3(1-f_{ck}(MPa)/250)b_{wo}zf_{cd}\sin 2\delta$ (5), $1 \leq \cot\delta \leq 2.5$		
$V_{Rd,s}$, outside critical regions(5)	As in EC2: $V_{Rd,s}=b_w z \rho_w f_{ywd} \cot\delta$ (5), $1 \leq \cot\delta \leq 2.5$		
$V_{Rd,s}$, critical regions(5)	$V_{Rd,s}=b_w z \rho_w f_{ywd}$ ($\delta=45^o$)	As in EC2: $V_{Rd,s}=b_w z \rho_w f_{ywd} \cot\delta$, $1 \leq \cot\delta \leq 2.5$	
If $\zeta \equiv V_{Emin}/V_{Emax}$(6) <-0.5: inclined bars at angle $\pm\alpha$ to beam axis, with cross-section A_s/direction	If $V_{Emax}/(2+\zeta)f_{ctd}b_w d>1$: $A_s=0.5V_{Emax}/f_{yd}\sin\alpha$ & stirrups for $0.5V_{Emax}$	-	

(4) At a member end where the moment capacities around the joint satisfy: $\Sigma M_{Rb} > \Sigma M_{Rc}$, M_{Rb} is replaced in the calculation of the design shear force, V_{Ed}, by $M_{Rb}(\Sigma M_{Rc}/\Sigma M_{Rb})$

(5) z: internal lever arm, taken equal to 0.9*d* or to the distance between the tension and the compression reinforcement, $d-d_1$.

(6) V_{Emax}, $V_{E,min}$ are the algebraically maximum and minimum values of V_{Ed} resulting from the ± sign; V_{emax} is the absolutely largest of the two values, and is taken positive in the calculation of ζ; the sign of V_{Emin} is determined according to whether it is the same as that of V_{Emax} or not.

Detailing/dimensioning of primary seismic columns (secondary ones: as in DCL

	DCH	DCM	DCL
Cross-section sides, $h_c, b_c \geq$	0.25m; $h_v/10$ if $\theta=P\delta/Vh>0.1$ (1)	-	
"critical region" length (1) $\geq$	$1.5h_c$, $1.5b_c$, 0.6m, $l_c/5$	h_c, b_c, 0.45m, $l_c/6$	h_c, b_c
Longitudinal bars (L):			
ρ_{min}	1%		$0.1N_d/A_cf_{yd}$, 0.2% (0)
ρ_{max}	4%		4% (0)
$d_{bL} \geq$	8mm		
bars per side $\geq$	3		2
Spacing between restrained bars	$\leq$150mm	$\leq$200mm	-
distance of unrestrained bar from	$\leq$150mm		

(0) Note (0) of Table of beams applies.

(1) h_v is the distance of the inflection point to the column end further away, for bending within a plane parallel to the side of interest; l_c is the column clear length.

Detailing & dimensioning of primary seismic columns *(cont'd)*

	DCH	DCM	DCL
Transverse bars (w):			
Outside critical regions:			
$d_{bw} \geq$	6mm, $d_{bL}/4$		
spacing $s_w \leq$	$20d_{bL}$, h_c, b_c, 400mm		$12d_{bL}$, $0.6h_c$, $0.6b_c$, 240mm
at lap splices, if d_{bL}>14mm: $s_w \leq$	$12d_{bL}$, $0.6h_c$, $0.6b_c$, 240mm		
Within critical regions:(2)			
$d_{bw} \geq$ (3)	6mm, $0.4(f_{yd}/f_{ywd})^{1/2}d_{bL}$	6mm, $d_{bL}/4$	
$s_w \leq$ (3),(4)	$6d_{bL}$, $b_o/3$, 125mm	$8d_{bL}$, $b_o/2$, 175mm	-
$\omega_{wd} \geq$ (5)	0.08	-	
$\alpha\omega_{wd} \geq$ (4),(5),(6),(7)	$30\mu_\phi^* \nu_d \varepsilon_{sy,d} b_c/b_o - 0.035$	-	
In critical region at column base:			
$\omega_{wd} \geq$	0.12	0.08	-
$\alpha\omega_{wd} \geq$ (4),(5),(6),(8),(9)	$30\mu_\phi \nu_d \varepsilon_{sy,d} b_c/b_o - 0.035$		-

(2) For DCM: If q ≤ 2 used in the design, the transverse reinforcement in critical regions of columns with axial load ratio ν_d not greater than 0.2 may follow the rules applying to DCL columns.

(3) For DCH: In the two lower storeys of the building, the requirements on d_{bw}, s_w apply over a distance from the end section not less than 1.5 times the critical region height.

(4) c denotes full concrete section; o the confined core (to centreline of perimeter hoop); b_o is the smallest side of this core.

(5) ω_{wd}: volume ratio of confining hoops to confined core (to centreline of perimeter hoop) times f_{yd}/f_{cd}

Detailing & dimensioning of primary seismic columns *(cont'd)*

	DCH	DCM	DCL
Transverse bars (w):			
Outside critical regions:			
$d_{bw} \geq$	$6mm$, $d_{bL}/4$		
spacing $s_w \leq$	$20d_{bL}$, h_c, b_c, 400mm		$12d_{bL}$, $0.6h_c$, $0.6b_c$, 240mm
at lap splices, if d_{bL}>14mm: $s_w \leq$	$12d_{bL}$, $0.6h_c$, $0.6b_c$, 240mm		
Within critical regions:(2)			
$d_{bw} \geq$ (3)	6mm, $0.4(f_{yd}/f_{ywd})^{1/2}d_{bL}$	6mm, $d_{bL}/4$	
$s_w \leq$ (3),(4)	$6d_{bL}$, $b_o/3$, 125mm	$8d_{bL}$, $b_o/2$, 175mm	-
$\omega_{wd} \geq$ (5)	0.08	-	
$\alpha\omega_{wd} \geq$ (4),(5),(6),(7)	$30\mu_\phi^* \nu_d \varepsilon_{sy,d} b_c/b_o - 0.035$	-	
In critical region at column base:			
$\omega_{wd} \geq$	0.12	0.08	-
$\alpha\omega_{wd} \geq$ (4),(5),(6),(8),(9)	$30\mu_\phi \nu_d \varepsilon_{sy,d} b_c/b_o - 0.035$		-

(6) α : confinement effectiveness factor, $\alpha=\alpha_s\alpha_n$; where $\alpha_s=(1-s/2b_o)(1-s/2h_o)$ for hoops, $\alpha_s=(1-s/2b_o)$ for spirals; α_n=1 for circular hoops, $\alpha_n=1-\{b_o/((n_h-1)h_o)+h_o/((n_b-1)b_o)\}/3$ for rect. hoops with n_b legs parallel to side of the core with length b_o and n_h legs parallel to the one with length h_o.

(7) For DCH: at column ends protected from plastic hinging by capacity design of the column, μ_ϕ^* is the curvature ductility factor corresponding to 2/3 of the basic value q_o of the behaviour factor used in the design; at column ends where plastic hinging is not prevented due to the exemptions in Note (10) below, μ_ϕ^* is the full value corresponding to q_o; $\varepsilon_{sy,d}= f_{yd}/E_s$.

(8) Note (1) of the Beams Table applies.

(9) For DCH: Requirement applies also in the critical regions at the ends of columns where plastic hinging is not prevented, because of the exemptions in Note (10) below.

Detailing & dimensioning of primary seismic columns *(cont'd)*

	DCH	DCM	DCL
Capacity design check at beam-column joints: (10)	$1.3\sum M_{Rb} \leq \sum M_{Rc}$ No moment in transverse direction of column		-
Verification for M_x-M_y-N:	Truly biaxial, or uniaxial with (M_z/0.7, N), (M_y/0.7, N)		
Axial load ratio $\nu_d = N_{Ed}/A_c f_{cd}$	≤ 0.55	≤ 0.65	-
Shear design:			
V_{Ed} seismic(11)	$1.3\frac{\sum M_{Rc}^{ends}}{l_{cl}}$ (11)	$1.1\frac{\sum M_{Rc}^{ends}}{l_{cl}}$ (11)	from analysis for design seismic action plus gravity
$V_{Rd,max}$ seismic (12), (13)	As in EC2: $V_{Rd,max}=0.3(1-f_{ck}(MPa)/250)b_{wo}zf_{cd}\sin 2\delta$, $1 \leq \cot\delta \leq 2.5$		
$V_{Rd,s}$ seismic (12), (13), (14)	As in EC2: $V_{Rd,s}=b_w z \rho_w f_{ywd}\cot\delta + N_{Ed}(h-x)/l_{cl}$(13), $1 \leq \cot\delta \leq 2.5$		

(10) The capacity design rule does not need to be met at beam-column joints: (a) of the top floor, (b) of the ground storey in two-storey buildings with axial load ratio $\nu_d \leq 0.3$ in all columns, (c) if shear walls resist ≥ 50% of base shear parallel to the plane of the frame (wall buildings or wall-equivalent dual), or (d) in one-out-of-four columns of plane frames with columns of similar size.

(11) At a member end where the moment capacities around the joint satisfy: $\sum M_{Rb} < \sum M_{Rc}$, M_{Rc} is replaced by $M_{Rc}(\sum M_{Rb}/\sum M_{Rc})$.

(12) z is the internal lever arm, equal to 0.9*d* or to the distance between the tension and the compression reinforcement, d-d_1.

(13) The axial load, N_{Ed}, and its normalized value, ν_d, are taken with their most unfavourable values for the shear verification in the seismic design situation (considering both the demand and the capacity).

(14) *x* is the neutral axis depth at the end section in the ULS of bending with axial load.

Detailing & dimensioning of ductile walls

	DCH	DCM	DCL
Web thickness, $b_{wo} \geq$	max(150mm, h_{storey}/20)		-
critical region length, h_{cr}	$\geq$ max(l_w, H_w/6) (1) $\leq$ min(2l_w, h_{storey}) if wall $\leq$6 storeys $\leq$ min(2l_w, 2h_{storey}) if wall > 6 storeys		-

(0) Notes (0) of the Beam & Column Tables apply.

(1) l_w is the long side of the rectangular wall section or rectangular part thereof; H_w is the total height of the wall; h_{storey} is the storey height.

Detailing & dimensioning of ductile walls *(cont'd)*

	DCH	DCM	DCL
Boundary elements:			
a) in critical region:			
- length l_c from edge ≥	$0.15l_w$, $1.5b_w$, length over which $\varepsilon_c > 0.0035$		-
- thickness b_w over l_c ≥	0.2m; $h_{st}/15$ if $l_c \leq \max(2b_w, l_w/5)$, $h_{st}/10$ if $l_c > \max(2b_w, l_w/5)$		-
- vertical reinforcement:			
ρ_{min} over $A_c = l_c b_w$	0.5%		0.2% (0)
ρ_{max} over A_c	4% (0)		
- confining hoops (w) (2):			
$d_{bw} \geq$	6mm, $0.4(f_{yd}/f_{ywd})^{1/2} d_{bL}$	6mm,	in the part of the section where $\rho_L > 2\%$: as over the rest of the wall (case b, below)
spacing $s_w \leq$ (3)	$6d_{bL}$, $b_o/3$, 125mm	$8d_{bL}$, $b_o/2$, 175mm	
$\omega_{wd} \geq$ (2)	0.12	0.08	
$\alpha\omega_{wd} \geq$ (3),(4)	$30\mu_\phi(\nu_d+\omega_v)\varepsilon_{sy,d} b_w/b_o - 0.035$		
b) over the rest of the wall height:	In parts of the section where $\varepsilon_c > 0.2\%$: $\rho_{v,min} = 0.5\%$; In parts of the section where $\rho_L > 2\%$: - distance of unrestrained bar in compression zone from nearest restrained bar ≤150mm; - hoops with $d_{bw} \geq \max(6\text{mm}, d_{bL}/4)$ & spacing $s_w \leq \min(12d_{bL}, 0.6b_{wo}, 240\text{mm})$ (0) up to a distance of $4b_w$ above or below floor beams or slabs, or $s_w \leq \min(20d_{bL}, b_{wo}, 400\text{mm})$ (0) beyond that distance		

(2) For DC M: If in the seismic design situation $\nu_d = N_{Ed}/A_c f_{cd} \leq 0.15$, the DCL rules may be applied for the boundary elements; these rules apply also if $\nu_d \leq 0.2$ but the q-value used in the design is ≤ of 85% of the value allowed when the DC M confining reinforcement is used in boundary elements.

(3) Notes (4), (5), (6) of the columns Table apply for the confined core of boundary elements.

(4) μ_ϕ is the curvature ductility factor corresponding to the product of q_o andthe ratio M_{Edo}/M_{Rdo} at the base of the wall; $\varepsilon_{sy,d} = f_{yd}/E_s$, ω_{vd} is the mechanical ratio of the vertical web reinforcement.

Detailing & dimensioning of ductile walls *(cont'd)*

	DCH	DCM	DCL
Web:			
- vertical bars (v):			
$\rho_{v,min}$	wherever ε_c>0.2%: 0.5%; elsewhere 0.2%		0.2%$^{(0)}$
$\rho_{v,max}$	4%		
$d_{bv} \geq$	8mm	-	
$d_{bv} \leq$	$b_{wo}/8$	-	
spacing $s_v \leq$	min(25d_{bv}, 250mm)	min(3b_{wo}, 400mm)	
- horizontal bars:			
ρ_{hmin}	0.2%	max(0.1%, 0.25ρ_v)$^{(0)}$	
$d_{bh} \geq$	8mm	-	
$d_{bh} \leq$	$b_{wo}/8$	-	
spacing $s_h \leq$	min(25d_{bh}, 250mm)	400mm	
axial load ratio ν_d= $N_{Ed}/A_c f_{cd}$	≤0.35	≤0.4	-
Design moments M_{Ed}*:*	If $H_w/l_w \geq 2$, design moments from linear envelope of maximum moments M_{Ed} from analysis for the "seismic design situation", shifted up by the "tension shift" a_l		from analysis for design seismic action & gravity

(0) Notes (0) of the Beam & Column Tables apply.

Detailing & dimensioning of ductile walls *(cont'd)*

	DCH	DCM	DCL
Shear design:			
Design shear force V_{Ed} = shear force V'_{Ed} from the analysis for the design seismic action, times factor ε:	if $H_w/l_w \le 2$(5): $\varepsilon = 1.2M_{Rdo}/M_{Edo} \le q$ if $H_w/l_w > 2$(5), (6): $\varepsilon = \sqrt{\left(1.2\frac{M_{Rdo}}{M_{Edo}}\right)^2 + 0.1\left(q\frac{S_e(T_C)}{S_e(T_1)}\right)^2} \le q$	ε=1.5	ε=1.0
Design shear force in walls of dual systems with $H_w/l_w>2$, for z between $H_w/3$ and H_w: (7)	$V_{Ed}(z) = \left(\frac{0.75z}{H_w} - \frac{1}{4}\right)\varepsilon V_{Ed}(0) + \left(1.5 - \frac{1.5z}{H_w}\right)\varepsilon V_{Ed}\left(\frac{H_w}{3}\right)$		from analysis for design seismic action & gravity
$V_{Rd,max}$ outside critical region	As in EC2: $V_{Rd,max}=0.3(1-f_{ck}(MPa)/250)b_{wo}(0.8l_w)f_{cd}\sin 2\delta$, with $1 \le \cot\delta \le 2.5$		
$V_{Rd,max}$ in critical region	40% of EC2 value	As in EC2	

(5) M_{edo} : moment at the wall base from the analysis for the seismic design situation;
M_{Rdo} : design moment resistance at the wall base for the axial force N_{Ed} from the same analysis

(6) $S_e(T_1)$: value of the elastic spectral acceleration at the period of the fundamental mode in the horizontal direction (closest to that) of the wall shear force being multiplied by ε;
$S_e(T_c)$: spectral acceleration at the corner period T_C of the elastic spectrum.

(7) A dual structural system is one where walls resist between 35 and 65% of the seismic base shear in the direction of the wall shear force considered; z is distance from the base of the wall.

Detailing & dimensioning of ductile walls *(cont'd)*

	DCH	DCM	DCL
Shear design:			
$V_{Rd,s}$ in critical region; web reinforcement ratios: ρ_h, ρ_v			
(i) if $\alpha_s=M_{Ed}/V_{Ed}l_w\geq 2$: $\rho_v=\rho_{v,min}$, ρ_h from $V_{Rd,s}$:	$V_{Rd,s}=b_{wo}(0.8l_w)\rho_h f_{ywd}$	As in EC2: $V_{Rd,s}=b_{wo}(0.8l_w)\rho_h f_{ywd}\cot\delta$, $1\leq\cot\delta\leq 2.5$	
(ii) if $\alpha_s<2$: ρ_h from $V_{Rd,s}$: (8)	$V_{Rd,s}=V_{Rd,c}+b_{wo}\alpha_s(0.75l_w)\rho_h f_{yhd}$	As in EC2: $V_{Rd,s}=b_{wo}(0.8l_w)\rho_h f_{ywd}\cot\delta$, $1\leq\cot\delta\leq 2.5$	
ρ_v from: (9)	$\rho_v f_{yvd}\geq\rho_h f_{yhd}-N_{Ed}/(0.8l_w b_{wo})$		
Resistance to sliding shear: via bars with total area A_{si} at angle $\pm\alpha$ to the horizontal (10)	$V_{Rd,s}=A_{si}f_{yd}\cos\alpha+A_{sv}\min(0.25f_{yd},\ 1.3\sqrt{(f_{yd}f_{cd})})+0.3(1-f_{ck}(\text{MPa})/250)b_{wo}xf_{cd}$		
$\rho_{v,min}$ at construction joints (9),(11)	$0.0025,\ \dfrac{1.3f_{ctd}-\dfrac{N_{Ed}}{A_c}}{f_{yd}+1.5\sqrt{f_{cd}f_{yd}}}$	-	

(8) If b_w & d in m, f_{cd} in MPa, ρ_L: tensile reinforcement ratio and N_{Ed} in kN, $V_{Rd,c}$ (in kN) is given by:

$$V_{Rd,c}=\left\{\max\left[180\left(100\rho_1\right)^{1/3},\ 35\sqrt{1+\sqrt{\frac{0.2}{d}}}\ f_{cd}^{1/6}\right]\left(1+\sqrt{\frac{0.2}{d}}\right)f_{cd}^{1/3}+0.15\frac{N_{Ed}}{A_c}\right\}b_w d$$

$N_{ed}>0$ for compression; min. value from analysis for seismic design situation; $V_{Rd,}=0$ for tension

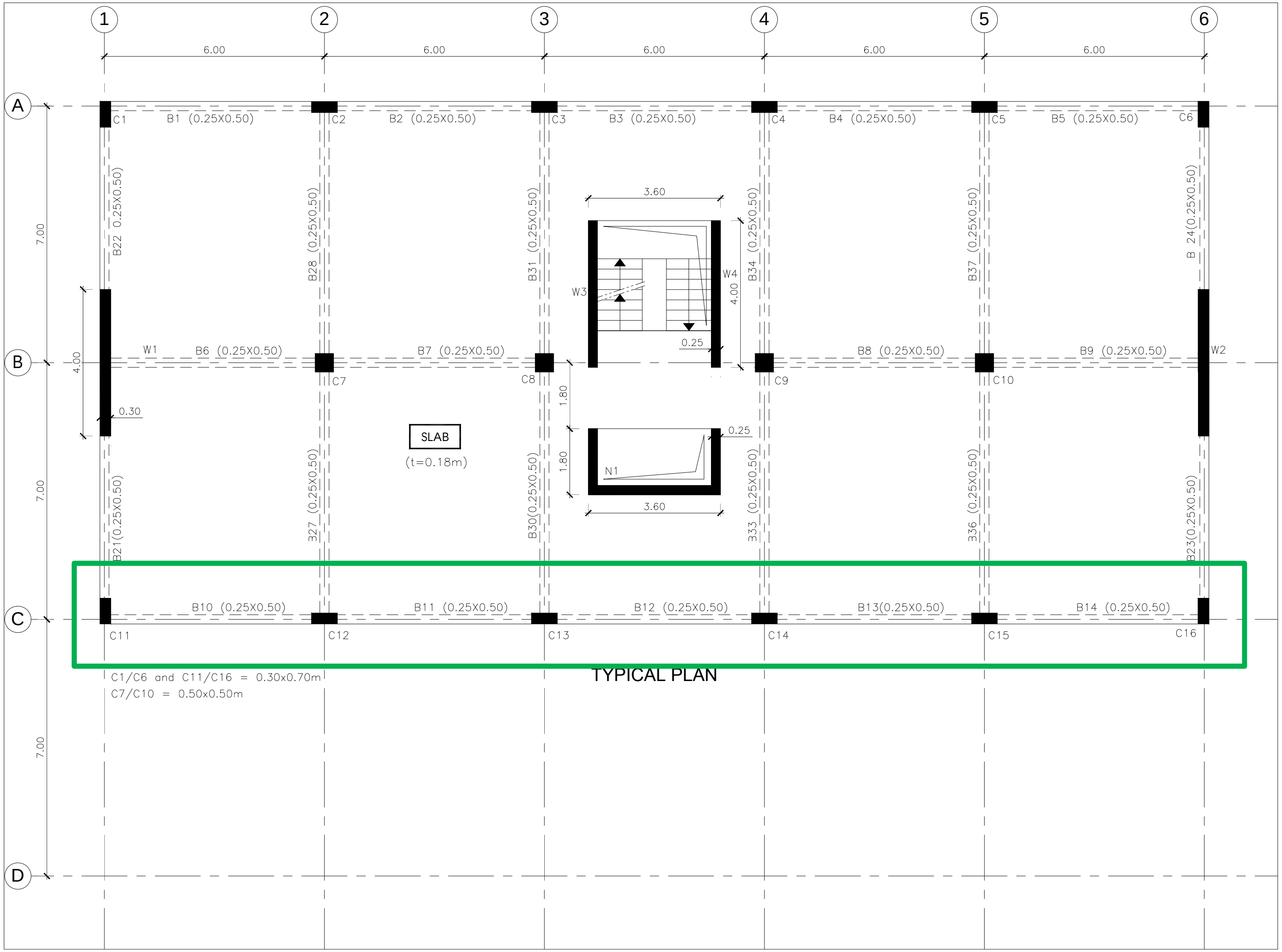
(9) $N_{Ed}>0$ for compression; use its minimum value from the analysis for the seismic design situation

(10) A_{sv}: total area of web vert. bars & of additional vert. bars in boundary elements for shear sliding

(11) $f_{ctd}=f_{ctk,0.05}/\gamma_c$: design value of (5%-fractile) tensile strength of concrete.

Example design of beams in flexure

Beam C



1
2
3
4
5
6
6.00
A
B
C
D
7.00
C1
B1 (0.25X0.50)
C2
B2 (0.25X0.50)
C3
B3 (0.25X0.50)
C4
B4 (0.25X0.50)
C5
B5 (0.25X0.50)
C6
W1
B6 (0.25X0.50)
C7
B7 (0.25X0.50)
C8
C9
B8 (0.25X0.50)
C10
B9 (0.25X0.50)
W2
W3
W4
N1
3.60
4.00
0.25
1.80
0.30
SLAB
(t=0.18m)
B10 (0.25X0.50)
B11 (0.25X0.50)
B12 (0.25X0.50)
B13(0.25X0.50)
B14 (0.25X0.50)
C11
C12
C13
C14
C15
C16
TYPICAL PLAN
C1/C6 and C11/C16 = 0.30x0.70m
C7/C10 = 0.50x0.50m

Beam C – storey 6

* STOREY: 6 * BEAMS: 10 11 12 13 14

* Concrete: C25 - Long. Reinforcement: S500 - Stirrups: S500 - Cover: 35(mm) *

GEOMETRY - BENDING MOMENTS MSd - LONGITUDINAL REINFORCEMENT

Beam: 10 | Length l: 5.50m | X-section L | Depth h: 0.50m | Width bw: 0.25m

L end: 10 | Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)
R end: 10 | Bot flange thickness (m): 0.00 (L end) - (centre) 0.00 (R end)

Location	Effect. fl width (m)	max MSd (kNm)	Required steel area (mm2)	Beam bars Contin	Beam bars Addit	Provided steel area (mm2)	Flexural capacity (kNm)
L end top	0.25	85.7	467.	3Φ12	--	486.	88.9
L end bot.	0.43	32.4	291.	3Φ12	--	339.	64.4
midspan	1.27	38.7	291.	3Φ12	--	339.	65.4
R end top	0.25	101.2	558.	3Φ12	--	526.	95.7
R end bot.	0.61	45.3	291.	3Φ12	--	339.	64.8

Note: Top reinforcement includes 250mm2 /m of effective slab width

Beam: 11 | Length l: 5.30m | X-section L | Depth h: 0.50m | Width bw: 0.25m

L end: 11 | Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)
R end: 11 | Bot flange thickness (m): 0.00 (L end) - (centre) 0.00 (R end)

Location	Effect. fl width (m)	max MSd (kNm)	Required steel area (mm2)	Beam bars Contin	Beam bars Addit	Provided steel area (mm2)	Flexural capacity (kNm)
L end top	0.25	117.0	653.	3Φ12	--	526.	95.7
L end bot.	0.61	56.6	327.	3Φ12	--	339.	64.8
midspan	1.09	27.3	291.	3Φ12	--	339.	65.3
R end top	0.25	124.9	702.	3Φ12	1Φ14	679.	121.3
R end bot.	0.61	46.0	351.	3Φ12	--	339.	64.8

Note: Top reinforcement includes 250mm2 /m of effective slab width

Beam: 12 | Length l: 5.30m | X-section L | Depth h: 0.50m | Width bw: 0.25m

L end: 12 | Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)
R end: 12 | Bot flange thickness (m): 0.00 (L end) - (centre) 0.00 (R end)

Location	Effect. fl width (m)	max MSd (kNm)	Required steel area (mm2)	Beam bars Contin	Beam bars Addit	Provided steel area (mm2)	Flexural capacity (kNm)
L end top	0.25	120.9	677.	3Φ12	1Φ14	679.	121.3
L end bot.	0.61	50.6	339.	3Φ12	--	339.	64.8
midspan	1.09	25.1	291.	3Φ12	--	339.	65.3
R end top	0.25	120.9	677.	3Φ12	1Φ14	679.	121.3
R end bot.	0.61	50.6	339.	3Φ12	--	339.	64.8

Note: Top reinforcement includes 250mm2 /m of effective slab width

JOINT GEOMETRY - SHEAR FORCES - VERIFICATION IN SHEAR

Joint	Max Φ (mm)	J width bj (m)	J hor. shear Vjh (kN)	J hor. shear strength (kN)	J hor. steel area Ash (mm2)	J ver. steel area Asv (mm2)
1	12	0.40	0.	807.	0.	0.
2	26	0.30	0.	1749.	0.	0.
3	26	0.30	0.	1765.	0.	0.
4	26	0.30	0.	1765.	0.	0.
5	26	0.30	0.	1749.	0.	0.
6	12	0.40	0.	807.	0.	0.

Beam C – storey 5

* STOREY: 5 * BEAMS: 10 11 12 13 14

* Concrete: C25 - Long. Reinforcement: S500 - Stirrups: S500 - Cover: 35(mm) *

GEOMETRY - BENDING MOMENTS MSd - LONGITUDINAL REINFORCEMENT

Beam: 10 | Length l: 5.50m | X-section L | Depth h: 0.50m | Width bw: 0.25m

L end: 10 | Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)

R end: 10 | Bot flange thickness (m): 0.00 (L end) - (centre) 0.00 (R end)

Location	Effect. fl width (m)	max MSd (kNm)	Required steel area (mm2)	Beam bars Contin	Beam bars Addit	Provided steel area (mm2)	Flexural capacity (kNm)
L end top	0.25	138.5	787.	3Φ12	1Φ12	639.	114.7
L end bot.	0.43	58.7	393.	3Φ12	1Φ12	452.	85.1
midspan	1.27	33.1	291.	3Φ12	--	339.	65.4
R end top	0.25	133.2	754.	3Φ12	1Φ16	727.	128.9
R end bot.	0.61	89.0	469.	3Φ12	1Φ20	653.	122.9

Note: Top reinforcement includes 250mm2 /m of effective slab width

JOINT GEOMETRY - SHEAR FORCES - VERIFICATION IN SHEAR

Joint	Max Φ (mm)	J width bj (m)	J hor. shear Vjh (kN)	J hor. shear strength (kN)	J hor. steel area Ash (mm2)	J ver. steel area Asv (mm2)
1	12	0.40	0.	764.	0.	0.
2	28	0.30	0.	1639.	0.	0.
3	26	0.30	0.	1673.	0.	0.
4	26	0.30	0.	1673.	0.	0.
5	28	0.30	0.	1639.	0.	0.
6	12	0.40	0.	764.	0.	0.

Beam: 11 | Length l: 5.30m | X-section L | Depth h: 0.50m | Width bw: 0.25m

L end: 11 | Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)

R end: 11 | Bot flange thickness (m): 0.00 (L end) - (centre) 0.00 (R end)

Location	Effect. fl width (m)	max MSd (kNm)	Required steel area (mm2)	Beam bars Contin	Beam bars Addit	Provided steel area (mm2)	Flexural capacity (kNm)
L end top	0.25	153.4	883.	3Φ12	2Φ16	928.	160.2
L end bot.	0.61	94.6	499.	3Φ12	1Φ20	653.	122.9
midspan	1.09	27.2	291.	3Φ12	--	339.	65.3
R end top	0.25	163.9	952.	3Φ12	2Φ16	928.	160.2
R end bot.	0.61	83.1	476.	3Φ12	1Φ20	653.	122.9

Note: Top reinforcement includes 250mm2 /m of effective slab width

Beam: 12 | Length l: 5.30m | X-section L | Depth h: 0.50m | Width bw: 0.25m

L end: 12 | Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)

R end: 12 | Bot flange thickness (m): 0.00 (L end) - (centre) 0.00 (R end)

Location	Effect. fl width (m)	max MSd (kNm)	Required steel area (mm2)	Beam bars Contin	Beam bars Addit	Provided steel area (mm2)	Flexural capacity (kNm)
L end top	0.25	159.4	922.	3Φ12	2Φ16	928.	160.2
L end bot.	0.61	89.9	473.	3Φ12	1Φ20	653.	122.9
midspan	1.09	25.8	291.	3Φ12	--	339.	65.3
R end top	0.25	159.4	922.	3Φ12	2Φ16	928.	160.2
R end bot.	0.61	89.9	473.	3Φ12	1Φ20	653.	122.9

Note: Top reinforcement includes 250mm2 /m of effective slab width

Beam C – storey 4

* STOREY: 4 * BEAMS: 10 11 12 13 14

* Concrete: C25 - Long. Reinforcement: S500 - Stirrups: S500 - Cover: 35(mm) *

GEOMETRY - BENDING MOMENTS MSd - LONGITUDINAL REINFORCEMENT

Beam: 10 | Length l: 5.50m | X-section L | Depth h: 0.50m | Width bw: 0.25m

L end: 10 | Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)
R end: 10 | Bot flange thickness (m): 0.00 (L end) - (centre) 0.00 (R end)

Location	Effect. fl width (m)	max MSd (kNm)	Required steel area (mm2)	Beam bars Contin	Beam bars Addit	Provided steel area (mm2)	Flexural capacity (kNm)
L end top	0.25	138.4	786.	3Φ12	1Φ12	687.	122.4
L end bot.	0.43	63.8	393.	3Φ12	1Φ12	452.	85.1
midspan	1.27	33.9	291.	3Φ12	--	339.	65.4
R end top	0.25	138.1	785.	3Φ12	1Φ18	780.	137.4
R end bot.	0.61	90.8	478.	3Φ12	1Φ20	653.	122.9

Note: Top reinforcement includes 250mm2 /m of effective slab width

JOINT GEOMETRY - SHEAR FORCES - VERIFICATION IN SHEAR

Joint	Max Φ (mm)	J width bj (m)	J hor. shear Vjh (kN)	J hor. shear strength (kN)	J hor. steel area Ash (mm2)	J ver. steel area Asv (mm2)
1	12	0.40	0.	719.	0.	0.
2	28	0.30	0.	1522.	0.	0.
3	28	0.30	0.	1577.	0.	0.
4	28	0.30	0.	1577.	0.	0.
5	28	0.30	0.	1522.	0.	0.
6	12	0.40	0.	719.	0.	0.

Beam: 11 | Length l: 5.30m | X-section L | Depth h: 0.50m | Width bw: 0.25m

L end: 11 | Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)
R end: 11 | Bot flange thickness (m): 0.00 (L end) - (centre) 0.00 (R end)

Location	Effect. fl width (m)	max MSd (kNm)	Required steel area (mm2)	Beam bars Contin	Beam bars Addit	Provided steel area (mm2)	Flexural capacity (kNm)
L end top	0.25	157.9	912.	3Φ12	2Φ18	1034.	182.6
L end bot.	0.61	97.8	517.	3Φ12	1Φ20	653.	122.9
midspan	1.09	27.2	291.	3Φ12	--	339.	65.3
R end top	0.25	167.0	973.	3Φ12	2Φ16	928.	160.2
R end bot.	0.61	87.3	487.	3Φ12	1Φ20	653.	122.9

Note: Top reinforcement includes 250mm2 /m of effective slab width

Beam: 12 | Length l: 5.30m | X-section L | Depth h: 0.50m | Width bw: 0.25m

L end: 12 | Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)
R end: 12 | Bot flange thickness (m): 0.00 (L end) - (centre) 0.00 (R end)

Location	Effect. fl width (m)	max MSd (kNm)	Required steel area (mm2)	Beam bars Contin	Beam bars Addit	Provided steel area (mm2)	Flexural capacity (kNm)
L end top	0.25	162.8	945.	3Φ12	2Φ16	928.	160.2
L end bot.	0.61	93.2	491.	3Φ12	1Φ20	653.	122.9
midspan	1.09	25.7	291.	3Φ12	--	339.	65.3
R end top	0.25	162.8	945.	3Φ12	2Φ16	928.	160.2
R end bot.	0.61	93.2	491.	3Φ12	1Φ20	653.	122.9

Note: Top reinforcement includes 250mm2 /m of effective slab width

Beam C – storey 3

* STOREY: 3 * BEAMS: 10 11 12 13 14

* Concrete: C25 - Long. Reinforcement: S500 - Stirrups: S500 - Cover: 35(mm) *

GEOMETRY - BENDING MOMENTS MSd - LONGITUDINAL REINFORCEMENT

Beam: 10	Length l: 5.50m	X-section L	Depth h: 0.50m	Width bw: 0.25m
L end: 10	Top flange thickness (m): 0.18 (L end)	0.18 (centre)	0.18 (R end)	
R end: 10	Bot flange thickness (m): 0.00 (L end)	- (centre)	0.00 (R end)	

Location	Effect. fl width (m)	max MSd (kNm)	Required steel area (mm2)	Beam bars Contin	Beam bars Addit	Provided steel area (mm2)	Flexural capacity (kNm)
L end top	0.25	139.8	795.	3Φ12	3Φ12	825.	144.4
L end bot.	0.43	66.7	398.	3Φ12	1Φ12	452.	85.1
midspan	1.27	33.6	291.	3Φ12	--	339.	65.4
R end top	0.25	141.7	807.	3Φ12	1Φ18	780.	137.4
R end bot.	0.61	92.2	486.	3Φ12	1Φ20	653.	122.9

Note: Top reinforcement includes 250mm2 /m of effective slab width

JOINT GEOMETRY - SHEAR FORCES - VERIFICATION IN SHEAR

Joint	Max Φ (mm)	J width bj (m)	J hor. shear Vjh (kN)	J hor. shear strength (kN)	J hor. steel area Ash (mm2)	J ver. steel area Asv (mm2)
1	12	0.40	0.	670.	0.	0.
2	28	0.30	0.	1396.	0.	0.
3	28	0.30	0.	1475.	0.	0.
4	28	0.30	0.	1475.	0.	0.
5	28	0.30	0.	1396.	0.	0.
6	12	0.40	0.	670.	0.	0.

Beam: 11	Length l: 5.30m	X-section L	Depth h: 0.50m	Width bw: 0.25m
L end: 11	Top flange thickness (m): 0.18 (L end)	0.18 (centre)	0.18 (R end)	
R end: 11	Bot flange thickness (m): 0.00 (L end)	- (centre)	0.00 (R end)	

Location	Effect. fl width (m)	max MSd (kNm)	Required steel area (mm2)	Beam bars Contin	Beam bars Addit	Provided steel area (mm2)	Flexural capacity (kNm)
L end top	0.25	161.0	933.	3Φ12	2Φ18	1034.	182.6
L end bot.	0.61	100.1	529.	3Φ12	1Φ20	653.	122.9
midspan	1.09	27.1	291.	3Φ12	--	339.	65.3
R end top	0.25	169.4	989.	3Φ12	2Φ16	928.	160.2
R end bot.	0.61	90.4	494.	3Φ12	1Φ20	653.	122.9

Note: Top reinforcement includes 250mm2 /m of effective slab width

Beam: 12	Length l: 5.30m	X-section L	Depth h: 0.50m	Width bw: 0.25m
L end: 12	Top flange thickness (m): 0.18 (L end)	0.18 (centre)	0.18 (R end)	
R end: 12	Bot flange thickness (m): 0.00 (L end)	- (centre)	0.00 (R end)	

Location	Effect. fl width (m)	max MSd (kNm)	Required steel area (mm2)	Beam bars Contin	Beam bars Addit	Provided steel area (mm2)	Flexural capacity (kNm)
L end top	0.25	165.4	962.	3Φ12	2Φ16	928.	160.2
L end bot.	0.61	95.8	506.	3Φ12	1Φ20	653.	122.9
midspan	1.09	25.7	291.	3Φ12	--	339.	65.3
R end top	0.25	165.4	962.	3Φ12	2Φ16	928.	160.2
R end bot.	0.61	95.8	506.	3Φ12	1Φ20	653.	122.9

Note: Top reinforcement includes 250mm2 /m of effective slab width

Beam C – storey 2

* STOREY: 2 * BEAMS: 10 11 12 13 14

* Concrete: C25 - Long. Reinforcement: S500 - Stirrups: S500 - Cover: 35(mm) *

GEOMETRY - BENDING MOMENTS MSd - LONGITUDINAL REINFORCEMENT

Beam: 10 | Length l: 5.50m | X-section L | Depth h: 0.50m | Width bw: 0.25m

L end: 10 | Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)
R end: 10 | Bot flange thickness (m): 0.00 (L end) - (centre) 0.00 (R end)

Location	Effect. fl width (m)	max MSd (kNm)	Required steel area (mm2)	Beam bars Contin	Beam bars Addit	Provided steel area (mm2)	Flexural capacity (kNm)
L end top	0.25	135.2	766.	3Φ12	1Φ12	740.	131.0
L end bot.	0.43	63.7	383.	3Φ12	1Φ12	452.	85.1
midspan	1.27	33.2	291.	3Φ12	--	339.	65.4
R end top	0.25	138.6	787.	3Φ12	1Φ18	780.	137.4
R end bot.	0.61	86.3	454.	3Φ12	1Φ20	653.	122.9

Note: Top reinforcement includes 250mm2 /m of effective slab width

JOINT GEOMETRY - SHEAR FORCES - VERIFICATION IN SHEAR

Joint	Max Φ (mm)	J width bj (m)	J hor. shear Vjh (kN)	J hor. shear strength (kN)	J hor. steel area Ash (mm2)	J ver. steel area Asv (mm2)
1	12	0.40	0.	621.	0.	0.
2	30	0.30	0.	1259.	0.	0.
3	30	0.30	0.	1368.	0.	0.
4	30	0.30	0.	1368.	0.	0.
5	30	0.30	0.	1259.	0.	0.
6	12	0.40	0.	621.	0.	0.

Beam: 11 | Length l: 5.30m | X-section L | Depth h: 0.50m | Width bw: 0.25m

L end: 11 | Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)
R end: 11 | Bot flange thickness (m): 0.00 (L end) - (centre) 0.00 (R end)

Location	Effect. fl width (m)	max MSd (kNm)	Required steel area (mm2)	Beam bars Contin	Beam bars Addit	Provided steel area (mm2)	Flexural capacity (kNm)
L end top	0.25	156.1	901.	3Φ12	2Φ18	1034.	182.6
L end bot.	0.61	94.0	496.	3Φ12	1Φ20	653.	122.9
midspan	1.09	27.1	291.	3Φ12	--	339.	65.3
R end top	0.25	163.4	949.	3Φ12	2Φ16	928.	160.2
R end bot.	0.61	85.6	474.	3Φ12	1Φ20	653.	122.9

Note: Top reinforcement includes 250mm2 /m of effective slab width

Beam: 12 | Length l: 5.30m | X-section L | Depth h: 0.50m | Width bw: 0.25m

L end: 12 | Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)
R end: 12 | Bot flange thickness (m): 0.00 (L end) - (centre) 0.00 (R end)

Location	Effect. fl width (m)	max MSd (kNm)	Required steel area (mm2)	Beam bars Contin	Beam bars Addit	Provided steel area (mm2)	Flexural capacity (kNm)
L end top	0.25	159.8	925.	3Φ12	2Φ16	928.	160.2
L end bot.	0.61	90.3	476.	3Φ12	1Φ20	653.	122.9
midspan	1.09	25.8	291.	3Φ12	--	339.	65.3
R end top	0.25	159.8	925.	3Φ12	2Φ16	928.	160.2
R end bot.	0.61	90.3	476.	3Φ12	1Φ20	653.	122.9

Note: Top reinforcement includes 250mm2 /m of effective slab width

Beam C – storey 1


```
* STOREY:  1 * BEAMS:   10   11   12   13   14
* Concrete: C25 - Long. Reinforcement: S500 - Stirrups: S500 - Cover: 35(mm)  *
```

GEOMETRY - BENDING MOMENTS MSd - LONGITUDINAL REINFORCEMENT

Beam: 10 | Length l: 5.50m | X-section L | Depth h: 0.50m | Width bw: 0.25m

L end: 10 | Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)
R end: 10 | Bot flange thickness (m): 0.00 (L end) - (centre) 0.00 (R end)

Location	Effect. fl width (m)	max MSd (kNm)	Required steel area (mm2)	Beam bars Contin	Beam bars Addit	Provided steel area (mm2)	Flexural capacity (kNm)
L end top	0.25	114.3	636.	3Φ12	1Φ12	740.	131.0
L end bot.	0.43	52.7	318.	3Φ12	--	339.	64.4
midspan	1.27	34.4	291.	3Φ12	--	339.	65.4
R end top	0.25	126.1	709.	3Φ12	1Φ14	679.	121.3
R end bot.	0.61	67.1	355.	3Φ12	--	339.	64.8

Note: Top reinforcement includes 250mm2 /m of effective slab width

JOINT GEOMETRY - SHEAR FORCES - VERIFICATION IN SHEAR

Joint	Max Φ (mm)	J width bj (m)	J hor. shear Vjh (kN)	J hor. shear strength (kN)	J hor. steel area Ash (mm2)	J ver. steel area Asv (mm2)
1	12	0.40	0.	574.	0.	0.
2	30	0.30	0.	1112.	0.	0.
3	30	0.30	0.	1257.	0.	0.
4	30	0.30	0.	1257.	0.	0.
5	30	0.30	0.	1112.	0.	0.
6	12	0.40	0.	574.	0.	0.

Beam: 11 | Length l: 5.30m | X-section L | Depth h: 0.50m | Width bw: 0.25m

L end: 11 | Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)
R end: 11 | Bot flange thickness (m): 0.00 (L end) - (centre) 0.00 (R end)

Location	Effect. fl width (m)	max MSd (kNm)	Required steel area (mm2)	Beam bars Contin	Beam bars Addit	Provided steel area (mm2)	Flexural capacity (kNm)
L end top	0.25	141.1	804.	3Φ12	2Φ14	833.	145.8
L end bot.	0.61	76.6	402.	3Φ12	1Φ20	653.	122.9
midspan	1.09	26.9	291.	3Φ12	--	339.	65.3
R end top	0.25	146.1	836.	3Φ12	2Φ14	833.	145.8
R end bot.	0.61	70.3	418.	3Φ12	1Φ20	653.	122.9

Note: Top reinforcement includes 250mm2 /m of effective slab width

Beam: 12 | Length l: 5.30m | X-section L | Depth h: 0.50m | Width bw: 0.25m

L end: 12 | Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)
R end: 12 | Bot flange thickness (m): 0.00 (L end) - (centre) 0.00 (R end)

Location	Effect. fl width (m)	max MSd (kNm)	Required steel area (mm2)	Beam bars Contin	Beam bars Addit	Provided steel area (mm2)	Flexural capacity (kNm)
L end top	0.25	143.1	816.	3Φ12	2Φ14	833.	145.8
L end bot.	0.61	73.7	408.	3Φ12	1Φ20	653.	122.9
midspan	1.09	25.8	291.	3Φ12	--	339.	65.3
R end top	0.25	143.1	816.	3Φ12	2Φ14	833.	145.8
R end bot.	0.61	73.7	408.	3Φ12	1Φ20	653.	122.9

Note: Top reinforcement includes 250mm2 /m of effective slab width

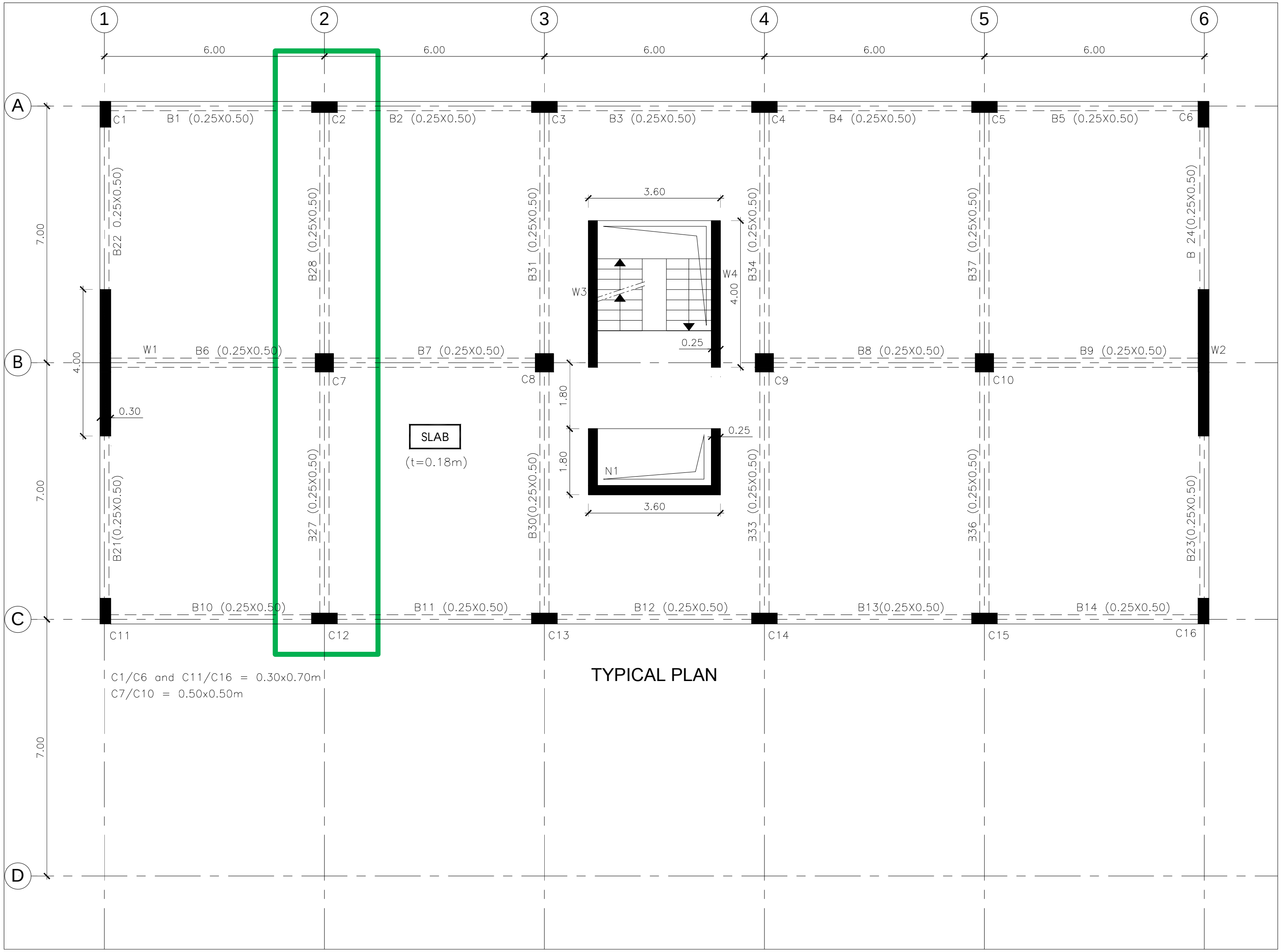
Beam C – storey 0


```
*-----------------------------------------------------------------------------*
* STOREY:  0 * BEAMS:   10   11   12   13   14
*-----------------------------------------------------------------------------*
* Concrete: C25 - Long. Reinforcement: S500 - Stirrups: S500 - Cover: 35(mm)  *
*-----------------------------------------------------------------------------*
          GEOMETRY - BENDING MOMENTS MSd - LONGITUDINAL REINFORCEMENT
+-----------------------------------------------------------------------------+
|Beam:    10| Length l: 5.50m|X-section L   | Depth h: 0.50m| Width bw: 0.25m |
|-----------+-----------------------------------------------------------------|
|L end:   10|Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)|
|R end:   10|Bot flange thickness (m): 0.00 (L end)  -   (centre) 0.00 (R end)|
|-----------+-----------------------------------------------------------------|
|  Location |Effect. | max MSd  | Required  | Beam bars    | Provided |Flexural|
|           |fl width|          |steel area |Contin Addit  |steel area|capacity|
|-----------+--(m)---+--(kNm)---+---(mm2)---+--------------+--(mm2)---+-(kNm)--|
|L end top  | 0.25   |   115.6  |    645.   | 2Φ10    3Φ14|    619.  |  111.3 |
|L end bot. | 0.43   |   -53.9  |    151.   | 2Φ10     -- |    157.  |   30.2 |
|midspan    | 1.27   |    56.0  |    290.   | 2Φ10    1Φ14|    311.  |   60.0 |
|R end top  | 0.25   |    92.7  |    508.   | 2Φ10    1Φ20|    471.  |   86.4 |
|R end bot. | 0.61   |   -30.1  |    151.   | 2Φ10     -- |    157.  |   30.3 |
+-----------------------------------------------------------------------------+
+-----------------------------------------------------------------------------+
|Beam:    11| Length l: 5.30m|X-section L   | Depth h: 0.50m| Width bw: 0.25m |
|-----------+-----------------------------------------------------------------|
|L end:   11|Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)|
|R end:   11|Bot flange thickness (m): 0.00 (L end)  -   (centre) 0.00 (R end)|
|-----------+-----------------------------------------------------------------|
|  Location |Effect. | max MSd  | Required  | Beam bars    | Provided |Flexural|
|           |fl width|          |steel area |Contin Addit  |steel area|capacity|
|-----------+--(m)---+--(kNm)---+---(mm2)---+--------------+--(mm2)---+-(kNm)--|
|L end top  | 0.25   |   105.7  |    585.   | 2Φ10    1Φ20|    471.  |   86.4 |
|L end bot. | 0.61   |   -29.1  |    151.   | 2Φ10     -- |    157.  |   30.3 |
|midspan    | 1.09   |    53.8  |    279.   | 2Φ10    1Φ14|    311.  |   59.9 |
|R end top  | 0.25   |   110.7  |    615.   | 2Φ10    2Φ16|    559.  |  101.4 |
|R end bot. | 0.61   |   -35.0  |    151.   | 2Φ10     -- |    157.  |   30.3 |
+-----------------------------------------------------------------------------+
+-----------------------------------------------------------------------------+
|Beam:    12| Length l: 5.30m|X-section L   | Depth h: 0.50m| Width bw: 0.25m |
|-----------+-----------------------------------------------------------------|
|L end:   12|Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)|
|R end:   12|Bot flange thickness (m): 0.00 (L end)  -   (centre) 0.00 (R end)|
|-----------+-----------------------------------------------------------------|
|  Location |Effect. | max MSd  | Required  | Beam bars    | Provided |Flexural|
|           |fl width|          |steel area |Contin Addit  |steel area|capacity|
|-----------+--(m)---+--(kNm)---+---(mm2)---+--------------+--(mm2)---+-(kNm)--|
|L end top  | 0.25   |   109.3  |    606.   | 2Φ10    2Φ16|    559.  |  101.4 |
|L end bot. | 0.61   |   -33.3  |    151.   | 2Φ10     -- |    157.  |   30.3 |
|midspan    | 1.09   |    53.7  |    279.   | 2Φ10    1Φ14|    311.  |   59.9 |
|R end top  | 0.25   |   109.3  |    606.   | 2Φ10    2Φ16|    559.  |  101.4 |
|R end bot. | 0.61   |   -33.3  |    151.   | 2Φ10     -- |    157.  |   30.3 |
+-----------------------------------------------------------------------------+
```

Beam C – storey -1


```
*------------------------------------------------------------------------------*
* STOREY: -1 * BEAMS:   10   11   12   13   14
*------------------------------------------------------------------------------*
* Concrete: C25 - Long. Reinforcement: S500 - Stirrups: S500 - Cover: 35(mm)   *
*------------------------------------------------------------------------------*
          GEOMETRY - BENDING MOMENTS MSd - LONGITUDINAL REINFORCEMENT
+------------------------------------------------------------------------------+
|Beam:    10| Length l: 5.50m|X-section L   | Depth h: 0.50m| Width bw: 0.25m |
|-----------+------------------------------------------------------------------|
|L end:   10|Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)|
|R end:   10|Bot flange thickness (m): 0.00 (L end)  -   (centre) 0.00 (R end)|
|-----------+------------------------------------------------------------------|
|  Location |Effect. | max MSd  | Required  | Beam bars    | Provided |Flexural|
|           |fl width|          |steel area |Contin Addit  |steel area|capacity|
|-----------+--(m)---+--(kNm)---+---(mm2)---+--------------+--(mm2)---+-(kNm)--|
|L end top  | 0.25   |   104.9  |    580.   | 2Φ10    2Φ16|    559.  |  101.4 |
|L end bot. | 0.43   |   -68.8  |    151.   | 2Φ10     -- |    157.  |   30.2 |
|midspan    | 1.27   |    56.8  |    295.   | 2Φ10    1Φ14|    311.  |   60.0 |
|R end top  | 0.25   |   101.7  |    561.   | 2Φ10    2Φ16|    559.  |  101.4 |
|R end bot. | 0.61   |   -65.3  |    151.   | 2Φ10     -- |    157.  |   30.3 |
+------------------------------------------------------------------------------+
+------------------------------------------------------------------------------+
|Beam:    11| Length l: 5.30m|X-section L   | Depth h: 0.50m| Width bw: 0.25m |
|-----------+------------------------------------------------------------------|
|L end:   11|Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)|
|R end:   11|Bot flange thickness (m): 0.00 (L end)  -   (centre) 0.00 (R end)|
|-----------+------------------------------------------------------------------|
|  Location |Effect. | max MSd  | Required  | Beam bars    | Provided |Flexural|
|           |fl width|          |steel area |Contin Addit  |steel area|capacity|
|-----------+--(m)---+--(kNm)---+---(mm2)---+--------------+--(mm2)---+-(kNm)--|
|L end top  | 0.25   |   105.0  |    580.   | 2Φ10    2Φ16|    559.  |  101.4 |
|L end bot. | 0.61   |   -65.9  |    151.   | 2Φ10     -- |    157.  |   30.3 |
|midspan    | 1.09   |    53.4  |    277.   | 2Φ10    1Φ14|    311.  |   59.9 |
|R end top  | 0.25   |   108.4  |    601.   | 2Φ10    2Φ16|    559.  |  101.4 |
|R end bot. | 0.61   |   -68.3  |    151.   | 2Φ10     -- |    157.  |   30.3 |
+------------------------------------------------------------------------------+
+------------------------------------------------------------------------------+
|Beam:    12| Length l: 5.30m|X-section L   | Depth h: 0.50m| Width bw: 0.25m |
|-----------+------------------------------------------------------------------|
|L end:   12|Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)|
|R end:   12|Bot flange thickness (m): 0.00 (L end)  -   (centre) 0.00 (R end)|
|-----------+------------------------------------------------------------------|
|  Location |Effect. | max MSd  | Required  | Beam bars    | Provided |Flexural|
|           |fl width|          |steel area |Contin Addit  |steel area|capacity|
|-----------+--(m)---+--(kNm)---+---(mm2)---+--------------+--(mm2)---+-(kNm)--|
|L end top  | 0.25   |   107.9  |    598.   | 2Φ10    2Φ16|    559.  |  101.4 |
|L end bot. | 0.61   |   -68.4  |    151.   | 2Φ10     -- |    157.  |   30.3 |
|midspan    | 1.09   |    53.9  |    279.   | 2Φ10    1Φ14|    311.  |   59.9 |
|R end top  | 0.25   |   107.9  |    598.   | 2Φ10    2Φ16|    559.  |  101.4 |
|R end bot. | 0.61   |   -68.4  |    151.   | 2Φ10     -- |    157.  |   30.3 |
+------------------------------------------------------------------------------+
```

Beam 2


1
2
3
4
5
6
6.00
A
B
C
D
7.00
4.00
C1
B1 (0.25X0.50)
C2
B2 (0.25X0.50)
C3
B3 (0.25X0.50)
C4
B4 (0.25X0.50)
C5
B5 (0.25X0.50)
C6
B22 0.25X0.50)
B28 (0.25X0.50)
B31 (0.25X0.50)
B34 (0.25X0.50)
B37 (0.25X0.50)
B 24(0.25X0.50)
3.60
W3
W4
0.25
W1
B6 (0.25X0.50)
C7
B7 (0.25X0.50)
C8
C9
B8 (0.25X0.50)
C10
B9 (0.25X0.50)
W2
0.30
1.80
SLAB
(t=0.18m)
N1
B21(0.25X0.50)
327 (0.25X0.50)
B30(0.25X0.50)
333 (0.25X0.50)
336 (0.25X0.50)
B23(0.25X0.50)
B10 (0.25X0.50)
B11 (0.25X0.50)
B12 (0.25X0.50)
B13(0.25X0.50)
B14 (0.25X0.50)
C11
C12
C13
C14
C15
C16
C1/C6 and C11/C16 = 0.30x0.70m
C7/C10 = 0.50x0.50m
TYPICAL PLAN

Beam 2 – storey 6

* STOREY: 6 * BEAMS: 28 27

* Concrete: C25 - Long. Reinforcement: S500 - Stirrups: S500 - Cover: 35(mm) *

GEOMETRY - BENDING MOMENTS MSd - LONGITUDINAL REINFORCEMENT

Beam: 28 | Length l: 6.60m | X-section T | Depth h: 0.50m | Width bw: 0.25m

L end: 28	Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)
R end: 28	Bot flange thickness (m): 0.00 (L end) - (centre) 0.00 (R end)

Location	Effect. fl width (m)	max MSd (kNm)	Required steel area (mm2)	Beam bars Contin	Addit	Provided steel area (mm2)	Flexural capacity (kNm)
L end top	0.25	118.6	663.	3Φ12	--	632.	113.5
L end bot.	0.67	-8.0	331.	3Φ12	--	339.	64.9
midspan	2.63	112.2	581.	3Φ12	2Φ14	647.	124.8
R end top	0.25	181.6	1072.	3Φ12	2Φ14	1070.	188.8
R end bot.	1.09	-53.5	536.	3Φ12	--	647.	123.5

Note: Top reinforcement includes 250mm2 /m of effective slab width
Note:1. Addit. bot. midspan bars extended: 2Φ14 to Right end.
2. Addit. bot. midspan bars extended to Left end of beam 2: 2Φ14

JOINT GEOMETRY - SHEAR FORCES - VERIFICATION IN SHEAR

Joint	Max Φ (mm)	J width bj (m)	J hor. shear Vjh (kN)	J hor. shear strength (kN)	J hor. steel area Ash (mm2)	J ver. steel area Asv (mm2)
1	12	0.40	0.	799.	0.	0.
2	18	0.50	0.	2013.	0.	0.
3	12	0.40	0.	799.	0.	0.

Beam: 27 | Length l: 6.60m | X-section T | Depth h: 0.50m | Width bw: 0.25m

L end: 27	Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)
R end: 27	Bot flange thickness (m): 0.00 (L end) - (centre) 0.00 (R end)

Location	Effect. fl width (m)	max MSd (kNm)	Required steel area (mm2)	Beam bars Contin	Addit	Provided steel area (mm2)	Flexural capacity (kNm)
L end top	0.25	184.1	1090.	3Φ12	2Φ14	1070.	188.8
L end bot.	1.09	-57.3	545.	3Φ12	--	647.	123.5
midspan	2.63	111.8	579.	3Φ12	2Φ14	647.	124.8
R end top	0.25	115.4	643.	3Φ12	--	632.	113.5
R end bot.	0.67	-5.6	322.	3Φ12	--	339.	64.9

Note: Top reinforcement includes 250mm2 /m of effective slab width
Note:1. Addit. bot. midspan bars of beam 2 ext. to L end of beam 1: 2Φ14

Beam 2 – storey 5


```
*--------------------------------------------------------------------------------*
* STOREY:  5 * BEAMS:   28   27
*--------------------------------------------------------------------------------*
* Concrete: C25 - Long. Reinforcement: S500 - Stirrups: S500 - Cover: 35(mm)   *
*--------------------------------------------------------------------------------*
          GEOMETRY - BENDING MOMENTS MSd - LONGITUDINAL REINFORCEMENT
+--------------------------------------------------------------------------------+
|Beam:    28| Length l: 6.60m|X-section T   | Depth h: 0.50m| Width bw: 0.25m |
|-----------+--------------------------------------------------------------------|
|L end:   28|Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)|
|R end:   28|Bot flange thickness (m): 0.00 (L end)  -   (centre) 0.00 (R end)|
|-----------+--------------------------------------------------------------------|
|  Location |Effect. | max MSd  | Required  | Beam bars   | Provided |Flexural|
|           |fl width|          |steel area |Contin Addit |steel area|capacity|
|-----------+--(m)---+--(kNm)---+---(mm2)---+-------------+--(mm2)---+-(kNm)--|
|L end top  | 0.25   |   186.3  |   1105.   | 3Φ12    4Φ12|   1084.  |  191.4 |
|L end bot. | 0.67   |    -4.0  |    553.   | 3Φ12    1Φ12|    606.  |  114.6 |
|midspan    | 2.63   |   100.0  |    518.   | 3Φ12    1Φ14|    493.  |   95.3 |
|R end top  | 0.25   |   200.5  |   1206.   | 3Φ12    2Φ16|   1164.  |  204.6 |
|R end bot. | 1.09   |    -2.8  |    603.   | 3Φ12    1Φ20|    807.  |  153.4 |
|Note: Top reinforcement includes 250mm2 /m of effective slab width           |
|Note:1. Addit. bot. midspan bars extended:  1Φ14 to L end - 1Φ14 to R end    |
|     2. Addit. bot. midspan bars extended to Left end of beam        2: 1Φ14 |
+--------------------------------------------------------------------------------+
+--------------------------------------------------------------------------------+
|Beam:    27| Length l: 6.60m|X-section T   | Depth h: 0.50m| Width bw: 0.25m |
|-----------+--------------------------------------------------------------------|
|L end:   27|Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)|
|R end:   27|Bot flange thickness (m): 0.00 (L end)  -   (centre) 0.00 (R end)|
|-----------+--------------------------------------------------------------------|
|  Location |Effect. | max MSd  | Required  | Beam bars   | Provided |Flexural|
|           |fl width|          |steel area |Contin Addit |steel area|capacity|
|-----------+--(m)---+--(kNm)---+---(mm2)---+-------------+--(mm2)---+-(kNm)--|
|L end top  | 0.25   |   204.6  |   1236.   | 3Φ12    2Φ16|   1164.  |  204.6 |
|L end bot. | 1.09   |    -8.5  |    618.   | 3Φ12    1Φ20|    807.  |  153.4 |
|midspan    | 2.63   |    99.7  |    516.   | 3Φ12    1Φ14|    493.  |   95.3 |
|R end top  | 0.25   |   181.2  |   1069.   | 3Φ12    4Φ12|   1084.  |  191.4 |
|R end bot. | 0.67   |    -0.1  |    535.   | 3Φ12    1Φ12|    606.  |  114.6 |
|Note: Top reinforcement includes 250mm2 /m of effective slab width           |
|Note:1. Addit. bot. midspan bars extended:  1Φ14 to L end - 1Φ14 to R end    |
|     2. Addit. bot. midspan bars extended to Right end of beam       1:  1Φ14|
|     3. Addit. bot. midspan bars of beam   2 ext. to L end of beam   1:  1Φ14|
+--------------------------------------------------------------------------------+
```

```
+------------------------------------------------------------------------------
  JOINT GEOMETRY - SHEAR FORCES - VERIFICATION IN SHEAR
+-----+-----+---------+-------------+-------------+-------------+------------
|Joint|Max Φ| J width | J hor. shear| J hor. shear| J hor. steel| J ver. steel
|     |     |   bj    |     Vjh     |   strength  |   area Ash  |   area Asv
+-----+-(mm)+---(m)---+----(kN)-----+----(kN)-----+----(mm2)----+----(mm2)----
|    1|  12 |   0.40  |         0.  |       747.  |         0.  |         0.
|    2|  20 |   0.50  |         0.  |      1824.  |         0.  |         0.
|    3|  12 |   0.40  |         0.  |       749.  |         0.  |         0.
+-----+-----+---------+-------------+-------------+-------------+------------
```

Beam 2 – storey 4


```
*-----------------------------------------------------------------------------*
* STOREY:  4 * BEAMS:   28   27
*-----------------------------------------------------------------------------*
* Concrete: C25 - Long. Reinforcement: S500 - Stirrups: S500 - Cover: 35(mm)  *
*-----------------------------------------------------------------------------*
          GEOMETRY - BENDING MOMENTS MSd - LONGITUDINAL REINFORCEMENT
+-----------------------------------------------------------------------------+
|Beam:    28| Length l: 6.60m|X-section T   | Depth h: 0.50m| Width bw: 0.25m |
|-----------+-----------------------------------------------------------------|
|L end:   28|Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)|
|R end:   28|Bot flange thickness (m): 0.00 (L end)  -   (centre) 0.00 (R end)|
|-----------+-----------------------------------------------------------------|
|  Location |Effect. | max MSd  | Required  | Beam bars    | Provided |Flexural|
|           |fl width|          |steel area |Contin Addit  |steel area|capacity|
|-----------+--(m)---+--(kNm)---+---(mm2)---+--------------+--(mm2)---+-(kNm)--|
|L end top  | 0.25   |   179.2  |   1056.   | 3Φ12    4Φ12|   1084.  |  191.3 |
|L end bot. | 0.67   |    -0.9  |    528.   | 3Φ12     -- |    647.  |  122.1 |
|midspan    | 2.63   |   101.5  |    525.   | 3Φ12    2Φ14|    647.  |  124.8 |
|R end top  | 0.25   |   201.7  |   1215.   | 3Φ12    3Φ14|   1224.  |  215.1 |
|R end bot. | 1.09   |    -7.9  |    607.   | 3Φ12     -- |    647.  |  123.5 |
|Note: Top reinforcement includes 250mm2 /m of effective slab width           |
|Note:1. Addit. bot. midspan bars extended:  2Φ14 to L end - 2Φ14 to R end    |
|     2. Addit. bot. midspan bars extended to Left end of beam        2: 2Φ14 |
+-----------------------------------------------------------------------------+
+-----------------------------------------------------------------------------+
|Beam:    27| Length l: 6.60m|X-section T   | Depth h: 0.50m| Width bw: 0.25m |
|-----------+-----------------------------------------------------------------|
|L end:   27|Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)|
|R end:   27|Bot flange thickness (m): 0.00 (L end)  -   (centre) 0.00 (R end)|
|-----------+-----------------------------------------------------------------|
|  Location |Effect. | max MSd  | Required  | Beam bars    | Provided |Flexural|
|           |fl width|          |steel area |Contin Addit  |steel area|capacity|
|-----------+--(m)---+--(kNm)---+---(mm2)---+--------------+--(mm2)---+-(kNm)--|
|L end top  | 0.25   |   205.7  |   1244.   | 3Φ12    3Φ14|   1224.  |  215.1 |
|L end bot. | 1.09   |   -13.4  |    622.   | 3Φ12     -- |    647.  |  123.5 |
|midspan    | 2.63   |   101.2  |    524.   | 3Φ12    2Φ14|    647.  |  124.8 |
|R end top  | 0.25   |   175.6  |   1031.   | 3Φ12    4Φ12|   1084.  |  191.2 |
|R end bot. | 0.67   |     1.5  |    516.   | 3Φ12     -- |    493.  |   93.7 |
|Note: Top reinforcement includes 250mm2 /m of effective slab width           |
|Note:1. Addit. bot. midspan bars extended:  1Φ14 to Right end.               |
|     2. Addit. bot. midspan bars of beam   2 ext. to L end of beam   1:  2Φ14|
+-----------------------------------------------------------------------------+
```

```
+-----------------------------------------------------------------------------
  JOINT GEOMETRY - SHEAR FORCES - VERIFICATION IN SHEAR
+-----+-----+---------+-------------+-------------+-------------+------------
|Joint|Max Φ| J width | J hor. shear| J hor. shear| J hor. steel| J ver. steel
|     |     |   bj    |     Vjh     |   strength  |   area Ash  |   area Asv
+-----+-(mm)+---(m)---+----(kN)-----+----(kN)-----+----(mm2)----+----(mm2)----
|    1|  12 |   0.40  |          0. |        693. |          0. |          0.
|    2|  22 |   0.50  |          0. |       1609. |          0. |          0.
|    3|  12 |   0.40  |          0. |        696. |          0. |          0.
+-----+-----+---------+-------------+-------------+-------------+------------
```

Beam 2 – storey 3


```
*----------------------------------------------------------------------------*
* STOREY:  3 * BEAMS:   28   27
*----------------------------------------------------------------------------*
* Concrete: C25 - Long. Reinforcement: S500 - Stirrups: S500 - Cover: 35(mm)  *
*----------------------------------------------------------------------------*
          GEOMETRY - BENDING MOMENTS MSd - LONGITUDINAL REINFORCEMENT
+----------------------------------------------------------------------------+
|Beam:    28| Length l: 6.60m|X-section T   | Depth h: 0.50m| Width bw: 0.25m |
|-----------+----------------------------------------------------------------|
|L end:   28|Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)|
|R end:   28|Bot flange thickness (m): 0.00 (L end)  -   (centre) 0.00 (R end)|
|-----------+----------------------------------------------------------------|
|  Location |Effect. | max MSd  | Required  | Beam bars    | Provided |Flexural|
|           |fl width|          |steel area |Contin Addit  |steel area|capacity|
|-----------+--(m)---+--(kNm)---+---(mm2)---+-------------+--(mm2)---+-(kNm)--|
|L end top  | 0.25   |   174.2  |   1022.   | 3Φ12    3Φ12|    971.  |  166.7 |
|L end bot. | 0.67   |    -0.4  |    511.   | 3Φ12     -- |    493.  |   93.7 |
|midspan    | 2.63   |   101.1  |    523.   | 3Φ12    2Φ14|    647.  |  124.8 |
|R end top  | 0.25   |   200.4  |   1205.   | 3Φ12    2Φ16|   1164.  |  205.1 |
|R end bot. | 1.09   |   -11.3  |    603.   | 3Φ12     -- |    647.  |  123.5 |
|Note: Top reinforcement includes 250mm2 /m of effective slab width           |
|Note:1. Addit. bot. midspan bars extended:  1Φ14 to L end - 2Φ14 to R end    |
|     2. Addit. bot. midspan bars extended to Left end of beam        2: 2Φ14 |
+----------------------------------------------------------------------------+
+----------------------------------------------------------------------------+
|Beam:    27| Length l: 6.60m|X-section T   | Depth h: 0.50m| Width bw: 0.25m |
|-----------+----------------------------------------------------------------|
|L end:   27|Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)|
|R end:   27|Bot flange thickness (m): 0.00 (L end)  -   (centre) 0.00 (R end)|
|-----------+----------------------------------------------------------------|
|  Location |Effect. | max MSd  | Required  | Beam bars    | Provided |Flexural|
|           |fl width|          |steel area |Contin Addit  |steel area|capacity|
|-----------+--(m)---+--(kNm)---+---(mm2)---+-------------+--(mm2)---+-(kNm)--|
|L end top  | 0.25   |   204.6  |   1236.   | 3Φ12    2Φ16|   1164.  |  205.1 |
|L end bot. | 1.09   |   -17.1  |    618.   | 3Φ12     -- |    647.  |  123.5 |
|midspan    | 2.63   |   100.9  |    522.   | 3Φ12    2Φ14|    647.  |  124.8 |
|R end top  | 0.25   |   171.2  |   1001.   | 3Φ12    3Φ12|    971.  |  166.7 |
|R end bot. | 0.67   |     1.4  |    501.   | 3Φ12     -- |    493.  |   93.7 |
|Note: Top reinforcement includes 250mm2 /m of effective slab width           |
|Note:1. Addit. bot. midspan bars extended:  1Φ14 to Right end.               |
|     2. Addit. bot. midspan bars of beam   2 ext. to L end of beam   1:  2Φ14|
+----------------------------------------------------------------------------+
```

```
+---------------------------------------------------------------------------
  JOINT GEOMETRY - SHEAR FORCES - VERIFICATION IN SHEAR
+-----+-----+---------+-------------+-------------+-------------+------------
|Joint|Max Φ| J width | J hor. shear| J hor. shear| J hor. steel| J ver. steel
|     |     |   bj    |     Vjh     |   strength  |   area Ash  |   area Asv
+-----+-(mm)+---(m)---+----(kN)-----+----(kN)-----+----(mm2)----+----(mm2)----
|    1|  12 |   0.40  |          0. |       633.  |         0.  |         0.
|    2|  22 |   0.50  |          0. |      1358.  |         0.  |         0.
|    3|  12 |   0.40  |          0. |       638.  |         0.  |         0.
+-----+-----+---------+-------------+-------------+-------------+------------
```

Beam 2 – storey 2


```
*--------------------------------------------------------------------------------*
* STOREY:  2 * BEAMS:   28   27
*--------------------------------------------------------------------------------*
* Concrete: C25 - Long. Reinforcement: S500 - Stirrups: S500 - Cover: 35(mm)  *
*--------------------------------------------------------------------------------*
          GEOMETRY - BENDING MOMENTS MSd - LONGITUDINAL REINFORCEMENT
+--------------------------------------------------------------------------------+
|Beam:    28| Length l: 6.60m|X-section T   | Depth h: 0.50m| Width bw: 0.25m |
|-----------+--------------------------------------------------------------------|
|L end:   28|Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)|
|R end:   28|Bot flange thickness (m): 0.00 (L end)  -   (centre) 0.00 (R end)|
|-----------+--------------------------------------------------------------------|
|  Location |Effect. | max MSd  | Required  | Beam bars    | Provided |Flexural|
|           |fl width|          |steel area |Contin Addit  |steel area|capacity|
|-----------+--(m)---+--(kNm)---+---(mm2)---+--------------+--(mm2)---+-(kNm)--|
|L end top  | 0.25   |   167.4  |    976.   | 3Φ12    3Φ12|    971.  |  166.7 |
|L end bot. | 0.67   |   -11.5  |    488.   | 3Φ12      -- |    493.  |   93.7 |
|midspan    | 2.63   |   100.4  |    520.   | 3Φ12    2Φ14|    647.  |  124.8 |
|R end top  | 0.25   |   191.7  |   1143.   | 3Φ12    3Φ12|   1101.  |  194.3 |
|R end bot. | 1.09   |   -22.1  |    572.   | 3Φ12      -- |    647.  |  123.5 |
|Note: Top reinforcement includes 250mm2 /m of effective slab width          |
|Note:1. Addit. bot. midspan bars extended:  1Φ14 to L end - 2Φ14 to R end    |
|     2. Addit. bot. midspan bars extended to Left end of beam        2: 2Φ14 |
+--------------------------------------------------------------------------------+
+--------------------------------------------------------------------------------+
|Beam:    27| Length l: 6.60m|X-section T   | Depth h: 0.50m| Width bw: 0.25m |
|-----------+--------------------------------------------------------------------|
|L end:   27|Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)|
|R end:   27|Bot flange thickness (m): 0.00 (L end)  -   (centre) 0.00 (R end)|
|-----------+--------------------------------------------------------------------|
|  Location |Effect. | max MSd  | Required  | Beam bars    | Provided |Flexural|
|           |fl width|          |steel area |Contin Addit  |steel area|capacity|
|-----------+--(m)---+--(kNm)---+---(mm2)---+--------------+--(mm2)---+-(kNm)--|
|L end top  | 0.25   |   193.2  |   1154.   | 3Φ12    3Φ12|   1101.  |  194.3 |
|L end bot. | 1.09   |   -25.1  |    577.   | 3Φ12      -- |    647.  |  123.5 |
|midspan    | 2.63   |   100.0  |    518.   | 3Φ12    1Φ14|    493.  |   95.3 |
|R end top  | 0.25   |   162.0  |    940.   | 3Φ12    3Φ12|    971.  |  166.7 |
|R end bot. | 0.67   |    -7.4  |    470.   | 3Φ12      -- |    493.  |   93.7 |
|Note: Top reinforcement includes 250mm2 /m of effective slab width          |
|Note:1. Addit. bot. midspan bars extended:  1Φ14 to Right end.              |
|     2. Addit. bot. midspan bars of beam   2 ext. to L end of beam    1:  2Φ14|
+--------------------------------------------------------------------------------+
```

```
+------------------------------------------------------------------------------
  JOINT GEOMETRY - SHEAR FORCES - VERIFICATION IN SHEAR
+-----+-----+---------+-------------+-------------+------------+------------
|Joint|Max Φ| J width | J hor. shear| J hor. shear| J hor. steel| J ver. steel
|     |     |   bj    |     Vjh     |   strength  |   area Ash  |   area Asv
+-----+-(mm)+---(m)---+----(kN)-----+----(kN)-----+----(mm2)----+----(mm2)----
|    1|  12 |  0.40   |          0. |        569. |          0. |          0.
|    2|  24 |  0.50   |          0. |       1048. |          0. |          0.
|    3|  12 |  0.40   |          0. |        575. |          0. |          0.
+-----+-----+---------+-------------+-------------+------------+------------
```

Beam 2 – storey 1


```
*----------------------------------------------------------------------------*
* STOREY:  1 * BEAMS:   28   27
*----------------------------------------------------------------------------*
* Concrete: C25 - Long. Reinforcement: S500 - Stirrups: S500 - Cover: 35(mm)  *
*----------------------------------------------------------------------------*
          GEOMETRY - BENDING MOMENTS MSd - LONGITUDINAL REINFORCEMENT
+----------------------------------------------------------------------------+
|Beam:    28| Length l: 6.60m|X-section T   | Depth h: 0.50m| Width bw: 0.25m |
|-----------+----------------------------------------------------------------|
|L end:   28|Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)|
|R end:   28|Bot flange thickness (m): 0.00 (L end)  -   (centre) 0.00 (R end)|
|-----------+----------------------------------------------------------------|
|  Location |Effect. | max MSd  | Required  | Beam bars    | Provided |Flexural|
|           |fl width|          |steel area |Contin Addit  |steel area|capacity|
|-----------+--(m)---+--(kNm)---+---(mm2)---+-------------+--(mm2)---+-(kNm)--|
|L end top  | 0.25   |   132.8  |    751.   | 2Φ14    1Φ14|    754.  |  133.3 |
|L end bot. | 0.67   |   -22.6  |    375.   | 2Φ14      -- |    462.  |   87.9 |
|midspan    | 2.63   |   103.7  |    537.   | 2Φ14    2Φ14|    616.  |  118.8 |
|R end top  | 0.25   |   174.4  |   1023.   | 2Φ14    2Φ14|   1038.  |  183.4 |
|R end bot. | 1.09   |   -54.0  |    511.   | 2Φ14      -- |    616.  |  117.6 |
|Note: Top reinforcement includes 250mm2 /m of effective slab width           |
|Note:1. Addit. bot. midspan bars extended:  1Φ14 to L end - 2Φ14 to R end    |
|     2. Addit. bot. midspan bars extended to Left end of beam        2: 2Φ14 |
+----------------------------------------------------------------------------+
+----------------------------------------------------------------------------+
|Beam:    27| Length l: 6.60m|X-section T   | Depth h: 0.50m| Width bw: 0.25m |
|-----------+----------------------------------------------------------------|
|L end:   27|Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)|
|R end:   27|Bot flange thickness (m): 0.00 (L end)  -   (centre) 0.00 (R end)|
|-----------+----------------------------------------------------------------|
|  Location |Effect. | max MSd  | Required  | Beam bars    | Provided |Flexural|
|           |fl width|          |steel area |Contin Addit  |steel area|capacity|
|-----------+--(m)---+--(kNm)---+---(mm2)---+-------------+--(mm2)---+-(kNm)--|
|L end top  | 0.25   |   181.3  |   1071.   | 2Φ14    2Φ14|   1038.  |  183.4 |
|L end bot. | 1.09   |   -60.3  |    535.   | 2Φ14      -- |    616.  |  117.6 |
|midspan    | 2.63   |   103.8  |    537.   | 2Φ14    2Φ14|    616.  |  118.8 |
|R end top  | 0.25   |   126.5  |    712.   | 2Φ14    1Φ12|    713.  |  126.8 |
|R end bot. | 0.67   |   -17.8  |    356.   | 2Φ14      -- |    462.  |   87.9 |
|Note: Top reinforcement includes 250mm2 /m of effective slab width           |
|Note:1. Addit. bot. midspan bars extended:  1Φ14 to Right end.               |
|     2. Addit. bot. midspan bars of beam   2 ext. to L end of beam    1:  2Φ14|
+----------------------------------------------------------------------------+
```

```
+-----------------------------------------------------------------------------
  JOINT GEOMETRY - SHEAR FORCES - VERIFICATION IN SHEAR
+-----+-----+---------+-------------+-------------+-------------+-------------
|Joint|Max Φ| J width | J hor. shear| J hor. shear| J hor. steel| J ver. steel
|     |     |   bj    |     Vjh     |   strength  |   area Ash  |   area Asv
+-----+-(mm)+---(m)---+----(kN)-----+----(kN)-----+----(mm2)----+----(mm2)----
|    1|  14 |  0.40   |          0. |       499.  |          0. |          0.
|    2|  24 |  0.50   |          0. |       570.  |          0. |          0.
|    3|  14 |  0.40   |          0. |       508.  |          0. |          0.
+-----+-----+---------+-------------+-------------+-------------+-------------
```

Beam 2 – storey 0

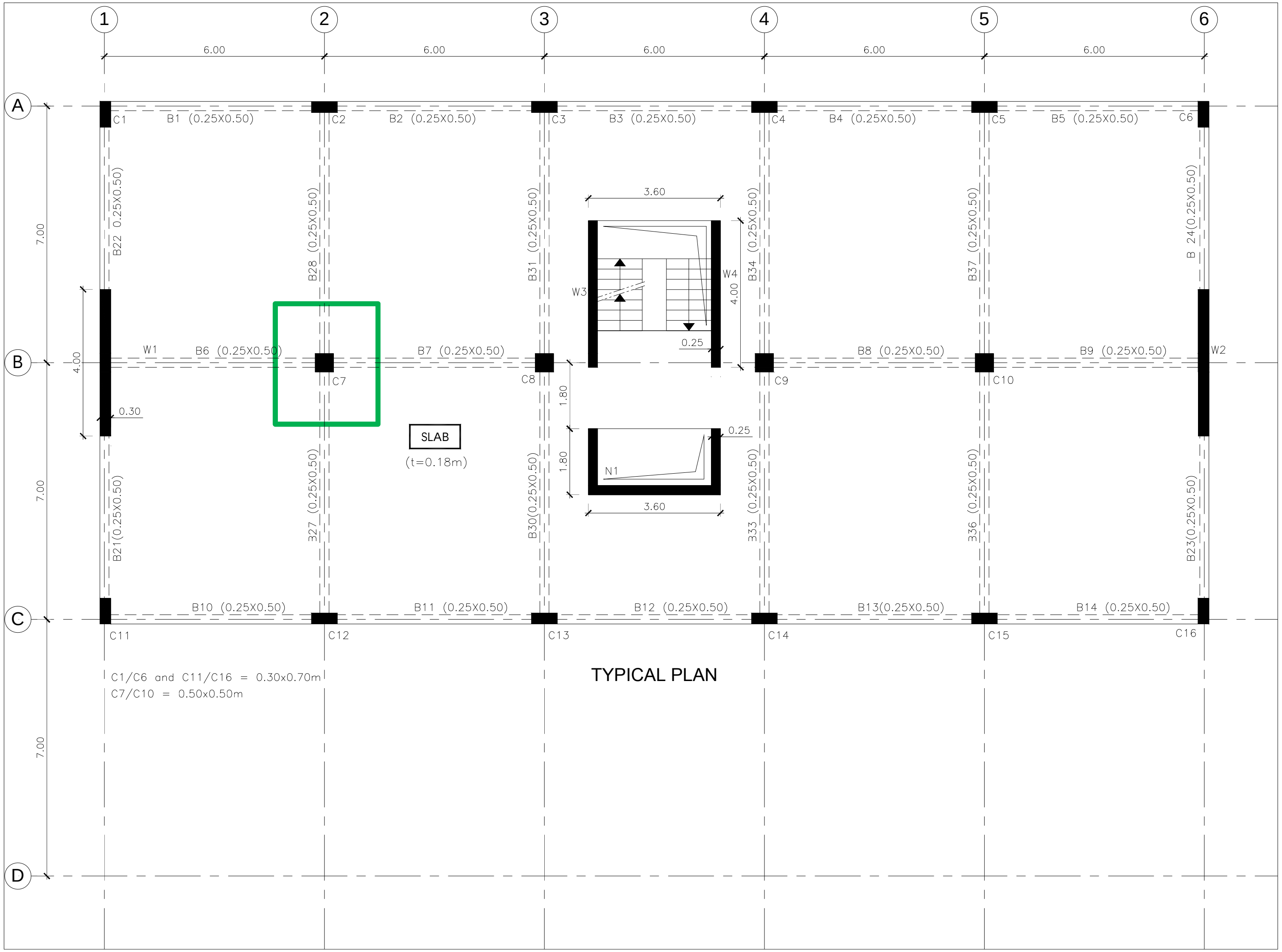

```
*-------------------------------------------------------------------------------*
* STOREY:  0 * BEAMS:   28   27   26
*-------------------------------------------------------------------------------*
* Concrete: C25 - Long. Reinforcement: S500 - Stirrups: S500 - Cover: 35(mm)   *
*-------------------------------------------------------------------------------*
          GEOMETRY - BENDING MOMENTS MSd - LONGITUDINAL REINFORCEMENT
+-------------------------------------------------------------------------------+
|Beam:    28| Length l: 6.60m|X-section T   | Depth h: 0.50m| Width bw: 0.25m |
|-----------+-------------------------------------------------------------------|
|L end:   28|Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)|
|R end:   28|Bot flange thickness (m): 0.00 (L end)  -   (centre) 0.00 (R end)|
|-----------+-------------------------------------------------------------------|
|  Location |Effect. | max MSd  | Required  | Beam bars    | Provided |Flexural|
|           |fl width|          |steel area |Contin Addit  |steel area|capacity|
|-----------+--(m)---+--(kNm)---+---(mm2)---+--------------+--(mm2)---+-(kNm)--|
|L end top  | 0.25   |   179.6  |   1058.   | 3Φ10    3Φ18|    999.  |  174.0 |
|L end bot. | 0.67   |  -106.8  |    151.   | 2Φ10     -- |    157.  |   30.3 |
|midspan    | 2.63   |    86.8  |    449.   | 2Φ10    2Φ14|    465.  |   89.9 |
|R end top  | 0.25   |   145.0  |    829.   | 3Φ10    3Φ16|    839.  |  146.6 |
|R end bot. | 1.09   |   -78.8  |    151.   | 2Φ10     -- |    157.  |   30.4 |
+-------------------------------------------------------------------------------+
+-------------------------------------------------------------------------------+
|Beam:    27| Length l: 6.60m|X-section T   | Depth h: 0.50m| Width bw: 0.25m |
|-----------+-------------------------------------------------------------------|
|L end:   27|Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)|
|R end:   27|Bot flange thickness (m): 0.00 (L end)  -   (centre) 0.00 (R end)|
|-----------+-------------------------------------------------------------------|
|  Location |Effect. | max MSd  | Required  | Beam bars    | Provided |Flexural|
|           |fl width|          |steel area |Contin Addit  |steel area|capacity|
|-----------+--(m)---+--(kNm)---+---(mm2)---+--------------+--(mm2)---+-(kNm)--|
|L end top  | 0.25   |   150.2  |    862.   | 3Φ10    3Φ16|    839.  |  146.6 |
|L end bot. | 1.09   |   -82.3  |    151.   | 2Φ10     -- |    157.  |   30.4 |
|midspan    | 2.21   |    83.5  |    432.   | 2Φ10    2Φ14|    465.  |   89.8 |
|R end top  | 0.25   |   181.0  |   1068.   | 3Φ10    7Φ12|   1027.  |  178.4 |
|R end bot. | 1.09   |  -106.9  |    151.   | 2Φ10     -- |    157.  |   30.4 |
+-------------------------------------------------------------------------------+
+-------------------------------------------------------------------------------+
|Beam:    26| Length l: 6.70m|X-section T   | Depth h: 0.50m| Width bw: 0.25m |
|-----------+-------------------------------------------------------------------|
|L end:   26|Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)|
|R end:   26|Bot flange thickness (m): 0.00 (L end)  -   (centre) 0.00 (R end)|
|-----------+-------------------------------------------------------------------|
|  Location |Effect. | max MSd  | Required  | Beam bars    | Provided |Flexural|
|           |fl width|          |steel area |Contin Addit  |steel area|capacity|
|-----------+--(m)---+--(kNm)---+---(mm2)---+--------------+--(mm2)---+-(kNm)--|
|L end top  | 0.25   |   159.7  |    924.   | 3Φ10    6Φ12|    914.  |  158.2 |
|L end bot. | 1.09   |   -97.0  |    151.   | 2Φ10     -- |    157.  |   30.4 |
|midspan    | 2.63   |    88.2  |    456.   | 2Φ10    2Φ14|    465.  |   89.9 |
|R end top  | 0.25   |   162.1  |    940.   | 3Φ10    6Φ12|    914.  |  158.2 |
|R end bot. | 0.67   |  -100.9  |    151.   | 2Φ10     -- |    157.  |   30.3 |
+-------------------------------------------------------------------------------+
```

Beam 2 – storey -1


```
*-----------------------------------------------------------------------------*
* STOREY: -1 * BEAMS:   28   27   26
*-----------------------------------------------------------------------------*
* Concrete: C25 - Long. Reinforcement: S500 - Stirrups: S500 - Cover: 35(mm)  *
*-----------------------------------------------------------------------------*
          GEOMETRY - BENDING MOMENTS MSd - LONGITUDINAL REINFORCEMENT
+-----------------------------------------------------------------------------+
|Beam:    28| Length l: 6.60m|X-section T   | Depth h: 0.50m| Width bw: 0.25m |
|-----------+-----------------------------------------------------------------|
|L end:   28|Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)|
|R end:   28|Bot flange thickness (m): 0.00 (L end)  -   (centre) 0.00 (R end)|
|-----------+-----------------------------------------------------------------|
|  Location |Effect. | max MSd  | Required  | Beam bars    | Provided |Flexural|
|           |fl width|          |steel area |Contin Addit  |steel area|capacity|
|-----------+--(m)---+--(kNm)---+---(mm2)---+--------------+--(mm2)---+-(kNm)--|
|L end top  | 0.25   |   163.1  |    947.   | 3Φ10    6Φ12|     914.  |  158.2 |
|L end bot. | 0.67   |  -104.0  |    151.   | 2Φ10      -- |     157.  |   30.3 |
|midspan    | 2.63   |    87.9  |    455.   | 2Φ10    2Φ14|     465.  |   89.9 |
|R end top  | 0.25   |   159.2  |    921.   | 3Φ10    2Φ20|     864.  |  150.5 |
|R end bot. | 1.09   |  -102.6  |    151.   | 2Φ10      -- |     157.  |   30.4 |
+-----------------------------------------------------------------------------+
+-----------------------------------------------------------------------------+
|Beam:    27| Length l: 6.60m|X-section T   | Depth h: 0.50m| Width bw: 0.25m |
|-----------+-----------------------------------------------------------------|
|L end:   27|Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)|
|R end:   27|Bot flange thickness (m): 0.00 (L end)  -   (centre) 0.00 (R end)|
|-----------+-----------------------------------------------------------------|
|  Location |Effect. | max MSd  | Required  | Beam bars    | Provided |Flexural|
|           |fl width|          |steel area |Contin Addit  |steel area|capacity|
|-----------+--(m)---+--(kNm)---+---(mm2)---+--------------+--(mm2)---+-(kNm)--|
|L end top  | 0.25   |   159.5  |    923.   | 3Φ10    2Φ20|     864.  |  150.5 |
|L end bot. | 1.09   |  -104.0  |    151.   | 2Φ10      -- |     157.  |   30.4 |
|midspan    | 2.21   |    83.4  |    432.   | 2Φ10    2Φ14|     465.  |   89.8 |
|R end top  | 0.25   |   171.9  |   1006.   | 3Φ10    7Φ12|    1027.  |  178.4 |
|R end bot. | 1.09   |  -111.9  |    151.   | 2Φ10      -- |     157.  |   30.4 |
+-----------------------------------------------------------------------------+
+-----------------------------------------------------------------------------+
|Beam:    26| Length l: 6.70m|X-section T   | Depth h: 0.50m| Width bw: 0.25m |
|-----------+-----------------------------------------------------------------|
|L end:   26|Top flange thickness (m): 0.18 (L end) 0.18 (centre) 0.18 (R end)|
|R end:   26|Bot flange thickness (m): 0.00 (L end)  -   (centre) 0.00 (R end)|
|-----------+-----------------------------------------------------------------|
|  Location |Effect. | max MSd  | Required  | Beam bars    | Provided |Flexural|
|           |fl width|          |steel area |Contin Addit  |steel area|capacity|
|-----------+--(m)---+--(kNm)---+---(mm2)---+--------------+--(mm2)---+-(kNm)--|
|L end top  | 0.25   |   166.7  |    971.   | 3Φ10    6Φ12|     914.  |  158.2 |
|L end bot. | 1.09   |  -105.9  |    151.   | 2Φ10      -- |     157.  |   30.4 |
|midspan    | 2.63   |    87.0  |    450.   | 2Φ10    2Φ14|     465.  |   89.9 |
|R end top  | 0.25   |   157.6  |    910.   | 3Φ10    2Φ20|     864.  |  150.5 |
|R end bot. | 0.67   |   -98.8  |    151.   | 2Φ10      -- |     157.  |   30.3 |
+-----------------------------------------------------------------------------+
```

Example design of columns

Column 7


1
2
3
4
5
6
A
B
C
D
6.00
7.00
4.00
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C14
C15
C16
B1 (0.25X0.50)
B2 (0.25X0.50)
B3 (0.25X0.50)
B4 (0.25X0.50)
B5 (0.25X0.50)
B6 (0.25X0.50)
B7 (0.25X0.50)
B8 (0.25X0.50)
B9 (0.25X0.50)
B10 (0.25X0.50)
B11 (0.25X0.50)
B12 (0.25X0.50)
B13(0.25X0.50)
B14 (0.25X0.50)
W1
W2
W3
W4
N1
0.30
3.60
0.25
1.80
SLAB
(t=0.18m)
C1/C6 and C11/C16 = 0.30x0.70m
C7/C10 = 0.50x0.50m
TYPICAL PLAN

Column 7

COLUMN: 7 GEOMETRY, NORMAL STRESS-RESULTANTS & LONGITUDINAL REINFORCEMENT

STOREY: 6	Base			Top		
Actions Combination	My (kNm)	Mz (kNm)	N (kN)	My (kNm)	Mz (kNm)	N (kN)
EN1990 Eq. 6.10a	-23.7	3.9	527.3	30.1	-4.8	502.0
EN1990 Eq. 6.10b	-22.5	3.7	499.7	28.6	-4.5	478.1
G+ψ2Q+E +X +Y/maxN	111.9	105.3	354.2	179.6	122.9	335.4
G+ψ2Q+E -X +Y/maxN	-143.2	105.3	354.2	-139.9	122.9	335.4
G+ψ2Q+E +X -Y/maxN	111.9	-100.0	354.2	179.6	-129.2	335.4
G+ψ2Q+E -X -Y/maxN	-143.2	-100.0	354.2	-139.9	-129.2	335.4
G+ψ2Q+E +X +Y/minN	111.9	105.3	346.0	179.6	122.9	327.2
G+ψ2Q+E -X +Y/minN	-143.2	105.3	346.0	-139.9	122.9	327.2
G+ψ2Q+E +X -Y/minN	111.9	-100.0	346.0	179.6	-129.2	327.2
G+ψ2Q+E -X -Y/minN	-143.2	-100.0	346.0	-139.9	-129.2	327.2

STOREY: 5	Base			Top		
Actions Combination	My (kNm)	Mz (kNm)	N (kN)	My (kNm)	Mz (kNm)	N (kN)
EN1990 Eq. 6.10a	-19.0	3.4	1021.6	18.4	-3.4	996.3
EN1990 Eq. 6.10b	-18.0	3.3	968.0	17.5	-3.2	946.5
G+ψ2Q+E +X +Y/maxN	113.2	97.2	685.7	139.6	91.2	667.0
G+ψ2Q+E -X +Y/maxN	-138.3	97.2	685.7	-115.2	91.2	667.0
G+ψ2Q+E +X -Y/maxN	113.2	-92.7	685.7	139.6	-95.7	667.0
G+ψ2Q+E -X -Y/maxN	-138.3	-92.7	685.7	-115.2	-95.7	667.0
G+ψ2Q+E +X +Y/minN	113.2	97.2	671.2	139.6	91.2	652.4
G+ψ2Q+E -X +Y/minN	-138.3	97.2	671.2	-115.2	91.2	652.4
G+ψ2Q+E +X -Y/minN	113.2	-92.7	671.2	139.6	-95.7	652.4
G+ψ2Q+E -X -Y/minN	-138.3	-92.7	671.2	-115.2	-95.7	652.4

Column 7

STOREY: 4	Base			Top		
Actions Combination	My (kNm)	Mz (kNm)	N (kN)	My (kNm)	Mz (kNm)	N (kN)
EN1990 Eq. 6.10a	-18.3	3.6	1524.4	18.9	-3.7	1499.1
EN1990 Eq. 6.10b	-17.4	3.4	1444.3	18.0	-3.5	1422.8
G+ψ2Q+E +X +Y/maxN	124.5	101.8	1023.1	150.9	94.9	1004.3
G+ψ2Q+E -X +Y/maxN	-148.6	101.8	1023.1	-125.8	94.9	1004.3
G+ψ2Q+E +X -Y/maxN	124.5	-97.0	1023.1	150.9	-99.8	1004.3
G+ψ2Q+E -X -Y/maxN	-148.6	-97.0	1023.1	-125.8	-99.8	1004.3
G+ψ2Q+E +X +Y/minN	124.5	101.8	1001.6	150.9	94.9	982.9
G+ψ2Q+E -X +Y/minN	-148.6	101.8	1001.6	-125.8	94.9	982.9
G+ψ2Q+E +X -Y/minN	124.5	-97.0	1001.6	150.9	-99.8	982.9
G+ψ2Q+E -X -Y/minN	-148.6	-97.0	1001.6	-125.8	-99.8	982.9

STOREY: 3	Base			Top		
Actions Combination	My (kNm)	Mz (kNm)	N (kN)	My (kNm)	Mz (kNm)	N (kN)
EN1990 Eq. 6.10a	-16.3	3.6	2030.4	17.0	-3.8	2005.1
EN1990 Eq. 6.10b	-15.5	3.4	1923.7	16.2	-3.6	1902.2
G+ψ2Q+E +X +Y/maxN	126.9	98.2	1362.7	146.9	85.7	1343.9
G+ψ2Q+E -X +Y/maxN	-148.6	98.2	1362.7	-124.3	85.7	1343.9
G+ψ2Q+E +X -Y/maxN	126.9	-93.4	1362.7	146.9	-90.8	1343.9
G+ψ2Q+E -X -Y/maxN	-148.6	-93.4	1362.7	-124.3	-90.8	1343.9
G+ψ2Q+E +X +Y/minN	126.9	98.2	1334.2	146.9	85.7	1315.4
G+ψ2Q+E -X +Y/minN	-148.6	98.2	1334.2	-124.3	85.7	1315.4
G+ψ2Q+E +X -Y/minN	126.9	-93.4	1334.2	146.9	-90.8	1315.4
G+ψ2Q+E -X -Y/minN	-148.6	-93.4	1334.2	-124.3	-90.8	1315.4

Column 7

STOREY: 2	Base			Top		
Actions Combination	My (kNm)	Mz (kNm)	N (kN)	My (kNm)	Mz (kNm)	N (kN)
EN1990 Eq. 6.10a	-14.9	4.6	2540.7	15.3	-4.3	2515.4
EN1990 Eq. 6.10b	-14.1	4.3	2407.2	14.5	-4.1	2385.7
G+ψ2Q+E +X +Y/maxN	130.9	94.4	1704.6	136.3	69.8	1685.9
G+ψ2Q+E -X +Y/maxN	-150.6	94.4	1704.6	-116.1	69.8	1685.9
G+ψ2Q+E +X -Y/maxN	130.9	-88.3	1704.6	136.3	-75.5	1685.9
G+ψ2Q+E -X -Y/maxN	-150.6	-88.3	1704.6	-116.1	-75.5	1685.9
G+ψ2Q+E +X +Y/minN	130.9	94.4	1670.0	136.3	69.8	1651.2
G+ψ2Q+E -X +Y/minN	-150.6	94.4	1670.0	-116.1	69.8	1651.2
G+ψ2Q+E +X -Y/minN	130.9	-88.3	1670.0	136.3	-75.5	1651.2
G+ψ2Q+E -X -Y/minN	-150.6	-88.3	1670.0	-116.1	-75.5	1651.2

STOREY: 1	Base			Top		
Actions Combination	My (kNm)	Mz (kNm)	N (kN)	My (kNm)	Mz (kNm)	N (kN)
EN1990 Eq. 6.10a	-9.9	2.8	3074.9	10.5	-3.6	3041.1
EN1990 Eq. 6.10b	-9.4	2.6	2912.6	10.0	-3.4	2883.9
G+ψ2Q+E +X +Y/maxN	103.2	52.7	2063.9	88.9	25.5	2038.9
G+ψ2Q+E -X +Y/maxN	-116.3	52.7	2063.9	-74.9	25.5	2038.9
G+ψ2Q+E +X -Y/maxN	103.2	-49.0	2063.9	88.9	-30.3	2038.9
G+ψ2Q+E -X -Y/maxN	-116.3	-49.0	2063.9	-74.9	-30.3	2038.9
G+ψ2Q+E +X +Y/minN	103.2	52.7	2021.2	88.9	25.5	1996.2
G+ψ2Q+E -X +Y/minN	-116.3	52.7	2021.2	-74.9	25.5	1996.2
G+ψ2Q+E +X -Y/minN	103.2	-49.0	2021.2	88.9	-30.3	1996.2
G+ψ2Q+E -X -Y/minN	-116.3	-49.0	2021.2	-74.9	-30.3	1996.2

Column 7

STOREY: 0	Base			Top		
Actions Combination	My (kNm)	Mz (kNm)	N (kN)	My (kNm)	Mz (kNm)	N (kN)
EN1990 Eq. 6.10a	-7.5	0.8	3579.1	9.9	-2.3	3553.8
EN1990 Eq. 6.10b	-7.2	0.7	3390.3	9.4	-2.1	3368.8
G+ψ2Q+E +X +Y/maxN	6.9	2.8	2396.4	43.3	15.3	2377.6
G+ψ2Q+E -X +Y/maxN	-16.9	2.8	2396.4	-30.3	15.3	2377.6
G+ψ2Q+E +X -Y/maxN	6.9	-1.8	2396.4	43.3	-18.4	2377.6
G+ψ2Q+E -X -Y/maxN	-16.9	-1.8	2396.4	-30.3	-18.4	2377.6
G+ψ2Q+E +X +Y/minN	6.9	2.8	2358.6	43.3	15.3	2339.8
G+ψ2Q+E -X +Y/minN	-16.9	2.8	2358.6	-30.3	15.3	2339.8
G+ψ2Q+E +X -Y/minN	6.9	-1.8	2358.6	43.3	-18.4	2339.8
G+ψ2Q+E -X -Y/minN	-16.9	-1.8	2358.6	-30.3	-18.4	2339.8

STOREY: -1	Base			Top		
Actions Combination	My (kNm)	Mz (kNm)	N (kN)	My (kNm)	Mz (kNm)	N (kN)
EN1990 Eq. 6.10a	-1.8	-0.2	4099.8	3.7	0.4	4074.5
EN1990 Eq. 6.10b	-1.7	-0.2	3883.7	3.5	0.4	3862.1
G+ψ2Q+E +X +Y/maxN	3.9	6.1	2742.7	8.6	5.8	2724.0
G+ψ2Q+E -X +Y/maxN	-6.2	6.1	2742.7	-3.7	5.8	2724.0
G+ψ2Q+E +X -Y/maxN	3.9	-6.4	2742.7	8.6	-5.2	2724.0
G+ψ2Q+E -X -Y/maxN	-6.2	-6.4	2742.7	-3.7	-5.2	2724.0
G+ψ2Q+E +X +Y/minN	3.9	6.1	2703.7	8.6	5.8	2684.9
G+ψ2Q+E -X +Y/minN	-6.2	6.1	2703.7	-3.7	5.8	2684.9
G+ψ2Q+E +X -Y/minN	3.9	-6.4	2703.7	8.6	-5.2	2684.9
G+ψ2Q+E -X -Y/minN	-6.2	-6.4	2703.7	-3.7	-5.2	2684.9

Column 7

SUM OF BEAM DESIGN MOMENT RESISTANCES MRd,b AROUND JOINT

Storey	Locat.	Direction of MRd Vector: +y (kNm)	-y (kNm)	+z (kNm)	-z (kNm)
6	Top	199.8	199.8	359.7	311.9
	Base	293.7	276.6	427.8	386.1
5	Top	293.7	276.6	427.8	386.1
	Base	313.2	282.8	438.3	356.2
4	Top	313.2	282.8	438.3	356.2
	Base	329.5	289.9	375.9	359.7
3	Top	329.5	289.9	375.9	359.7
	Base	336.2	287.4	365.1	327.6
2	Top	336.2	287.4	365.1	327.6
	Base	279.4	279.4	299.4	275.7
1	Top	279.4	279.4	299.4	275.7
	Base	116.8	116.8	146.6	30.4
0	Top	116.8	116.8	146.6	30.4
	Base	140.2	121.1	150.5	30.4
-1	Top	140.2	121.1	150.5	30.4
	Base	0.0	0.0	0.0	0.0

Column 7

COLUMN DESIGN MOMENT RESISTANCE MRd,c (for minN/maxN)

Storey	Locat.	+y (kNm)	-y (kNm)	+z (kNm)	-z (kNm)
6	Top	307.9/ 309.5	-307.9/ -309.5	307.9/ 309.5	-307.9/ -309.5
	Base	311.5/ 313.1	-311.5/ -313.1	311.5/ 313.1	-311.5/ -313.1
5	Top	387.7/ 389.0	-387.7/ -389.0	387.7/ 389.0	-387.7/ -389.0
	Base	389.3/ 390.6	-389.3/ -390.6	389.3/ 390.6	-389.3/ -390.6
4	Top	412.3/ 413.6	-412.3/ -413.6	412.3/ 413.6	-412.3/ -413.6
	Base	413.4/ 414.7	-413.4/ -414.7	413.4/ 414.7	-413.4/ -414.7
3	Top	427.5/ 428.3	-427.5/ -428.3	427.5/ 428.3	-427.5/ -428.3
	Base	428.0/ 428.9	-428.0/ -428.9	428.0/ 428.9	-428.0/ -428.9
2	Top	433.0/ 433.0	-433.0/ -433.0	433.0/ 433.0	-433.0/ -433.0
	Base	433.0/ 433.0	-433.0/ -433.0	433.0/ 433.0	-433.0/ -433.0
1	Top	437.2/ 434.2	-437.2/ -434.2	437.2/ 434.2	-437.2/ -434.2
	Base	435.4/ 432.5	-435.4/ -432.5	435.4/ 432.5	-435.4/ -432.5
0	Top	412.7/ 409.9	-412.7/ -409.9	412.7/ 409.9	-412.7/ -409.9
	Base	411.3/ 408.5	-411.3/ -408.5	411.3/ 408.5	-411.3/ -408.5
-1	Top	386.3/ 383.1	-386.3/ -383.1	386.3/ 383.1	-386.3/ -383.1
	Base	384.8/ 381.6	-384.8/ -381.6	384.8/ 381.6	-384.8/ -381.6

Column 7

DESIGN OF TRANSVERSE REINFORCEMENT IN SHEAR (for maxN/minN)

Storey	Des. Shear VEd (kN) y	Des. Shear VEd (kN) z	Provided Ties dia. (mm)	Provided Ties legs y	Provided Ties legs z	Provided Ties spacing-s middle-mm	strut angle (deg) y	strut angle (deg) z	VR,s (middle-kN) y	VR,s (middle-kN) z	VR,max (middle-kN) y	VR,max (middle-kN) z
6 maxN	88.	136.	6	4.0	4.0	170	21	21	350.	350.	629.	629.
minN	88.	135.					21	21	346.	346.	629.	629.
5 maxN	72.	88.	6	4.0	4.0	170	21	21	403.	403.	629.	629.
minN	72.	88.					21	21	398.	398.	629.	629.
4 maxN	71.	77.	6	4.0	4.0	170	21	21	457.	457.	629.	629.
minN	71.	77.					21	21	451.	451.	629.	629.
3 maxN	74.	74.	6	4.0	4.0	170	21	21	512.	512.	629.	629.
minN	74.	74.					21	21	504.	504.	629.	629.
2 maxN	74.	70.	6	4.0	4.0	170	21	21	567.	567.	629.	629.
minN	74.	70.					21	21	558.	558.	629.	629.
1 maxN	44.	47.	6	4.0	4.0	170	21	21	530.	530.	629.	629.
minN	44.	48.					21	21	522.	522.	629.	629.
0 maxN	3.	4.	6	4.0	4.0	170	23	23	658.	658.	661.	661.
minN	3.	4.					22	22	652.	652.	655.	655.
-1 maxN	0.	4.	6	4.0	4.0	170	24	24	692.	692.	698.	698.
minN	0.	4.					24	24	686.	686.	692.	692.

Column 7

CONFINEMENT REINFORCEMENT AT COLUMN ENDS (for maxN/minN)

Story	Wwd-req. base	Wwd-req. top	aWwd-req. base	aWwd-req. top	Stirrups dia. (mm)	Stirrups legs y	Stirrups legs z	Stirrups spacing-mm base	Stirrups spacing-mm top	Wwd-prov. base	Wwd-prov. top	aWwd-prov. base	aWwd-prov. top
6	0.00	0.00	0.000	0.000	6	4.0	4.0	110	110	0.130	0.130	0.078	0.078
5	0.00	0.00	0.000	0.000	6	4.0	4.0	110	110	0.130	0.130	0.078	0.078
4	0.00	0.00	0.000	0.000	6	4.0	4.0	110	110	0.130	0.130	0.078	0.078
3	0.00	0.00	0.000	0.000	6	4.0	4.0	110	110	0.130	0.130	0.078	0.078
2	0.00	0.00	0.000	0.000	6	4.0	4.0	110	110	0.130	0.130	0.078	0.078
1	0.08	0.00	0.146	0.000	8	4.0	4.0	105	110	0.242	0.231	0.147	0.138
0	0.00	0.00	0.000	0.000	6	4.0	4.0	110	110	0.130	0.130	0.078	0.078
-1	0.00	0.00	0.000	0.000	6	4.0	4.0	110	110	0.130	0.130	0.078	0.078

Column 7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+-----------------------------------------------------------------------------+
     FOOTING OF COLUMN :    7
Undr. shear strength in seismic design sitation: 270kPa in Eqs.6.10a/b: 300kPa
Friction angle & cohesion under drained conditions for Eqs.6.10a/b: 20deg,50kPa
+-----------------------------------------------------------------------------+
|footing depth h(m): 0.80|footing plan dimension(m): //y by= 2.00 //z bz= 2.00|
|found. depth  (m): 0.80  |column X-sect.dimensions(m): //y cy=0.50 //z cz=0.50|
|                         |column axis eccentricity(m): //y ay=0.00 //z az=0.00|
+-----------------------------------------------------------------------------+
 FOUNDATION DESIGN FORCES AT FOOTING CENTRE - SOIL BEARING PRESSURE & CAPACITY
+-----------------------------------------------------------------------------+
|   Combination    |Cap-Des|  N     My ey/by  Vy   Mz ez/bz  Vz   Soil Bearing |
|    of Actions    |magnif.|total                                press./capacity|
+-----------------+-------+-(kN)-(kNm)------(kN)-(kNm)-----(kN)-------(kPa)----+
|EN1990 Eq. 6.10a*|   -    | 4207   -1 0.000   0     0 0.000   0   1052.4/1284.5|
|EN1990 Eq. 6.10b*|   -    | 3975   -1 0.000   0     0 0.000   0    994.3/1284.5|
|G+ψ2Q+E +X/+Y/max| 3.000 | 2861   21 0.005   9    27 0.004  11    728.0/1686.0|
|G+ψ2Q+E -X/+Y/max| 2.909 | 2859   25 0.005  12    26 0.004  11    728.3/1686.1|
|G+ψ2Q+E +X/-Y/max| 3.000 | 2861   21 0.005   9    28 0.004  11    728.2/1685.9|
|G+ψ2Q+E -X/-Y/max| 2.909 | 2859   25 0.005  12    27 0.004  11    728.4/1686.0|
|G+ψ2Q+E +X/+Y/min| 3.000 | 2744   21 0.005   9    27 0.004  11    698.8/1686.0|
|G+ψ2Q+E -X/+Y/min| 2.930 | 2746   25 0.005  12    27 0.005  11    699.9/1686.1|
|G+ψ2Q+E +X/-Y/min| 3.000 | 2744   21 0.005   9    28 0.004  11    698.9/1685.9|
|G+ψ2Q+E -X/-Y/min| 2.930 | 2746   25 0.005  12    27 0.005  11    700.0/1686.0|
+-----------------------------------------------------------------------------+
*Note: The most unfavourable outcome of the application of 6.10a/6.10b applies.
+-----------------------------------------------------------------------------+
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Column 7

ULS DESIGN OF FOOTING IN SHEAR & PUNCHING SHEAR

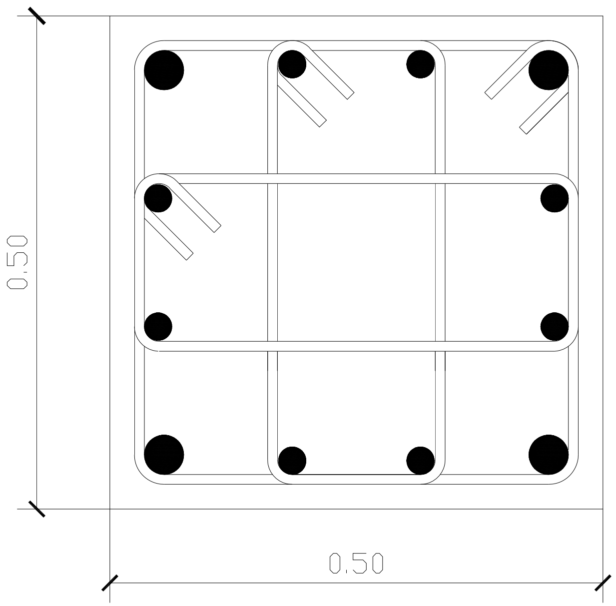
Combination of Actions	Shear stress vEd sect.//y vEdy/bzd (kPa)	Shear stress vEd sect.//z VEdz/byd (kPa)	Shear Resist. vRd,c (kPa)	Punching shear at distance av: max stress maxvEd (kPa)	av: crit. distance (m)	Resistance (2d/av)vRd (kPa)
EN1990 Eq. 6.10a*	16.8	16.8	328.1	576.9	0.5	1009.6
EN1990 Eq. 6.10b*	15.9	15.8	328.1	544.4	0.5	1009.6
G+ψ2Q+E +X/+Y/max	11.6	11.6	328.1	393.4	0.5	1009.6
G+ψ2Q+E -X/+Y/max	11.6	11.6	328.1	393.4	0.5	1009.6
G+ψ2Q+E +X/-Y/max	11.6	11.7	328.1	393.5	0.5	1009.6
G+ψ2Q+E -X/-Y/max	11.6	11.6	328.1	393.5	0.5	1009.6
G+ψ2Q+E +X/+Y/min	11.1	11.2	328.1	377.1	0.5	1009.6
G+ψ2Q+E -X/+Y/min	11.1	11.2	328.1	377.5	0.5	1009.6
G+ψ2Q+E +X/-Y/min	11.1	11.2	328.1	377.1	0.5	1009.6
G+ψ2Q+E -X/-Y/min	11.1	11.2	328.1	377.6	0.5	1009.6

*Note: The most unfavourable outcome of the application of 6.10a/6.10b applies.

ULS DESIGN OF TWO-WAY REINFORCEMENT AT FOOTING BOTTOM

Maximum bending moments: Vert. section //bz MEdy/bz (kNm/m)	Combinat.	Vert. section //by MEdz/by (kNm/m)	Combinat.	Reinforcement: Bar dia. (mm)	//by spacing (mm)	//by No.	//bz spacing (mm)	//bz No.
286.8	1	286.5	1	12	110	18	110	18

Reinforcement of columns



Column C7

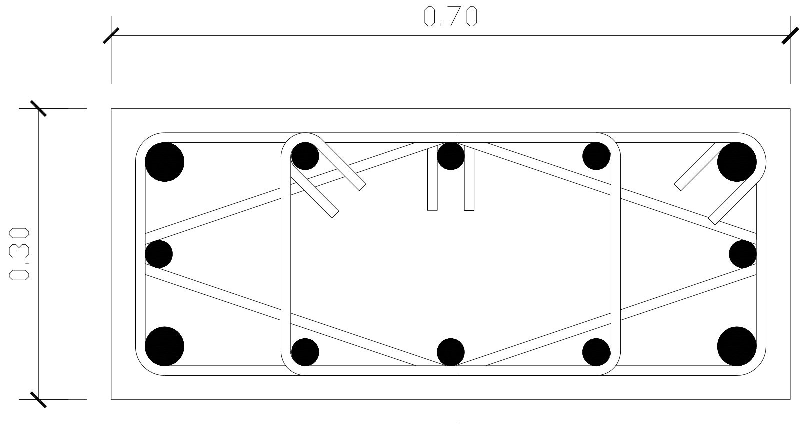
Longitudinal: 4Φ20 & 8Φ14

Trans. at base of ground storey: Φ8/105 in h_{cr}=0.50m

Trans. all other storeys: Φ6/110 in h_{cr}=0.50m

Trans. (outside h_{cr}): Φ6/170

Reinforcement of columns



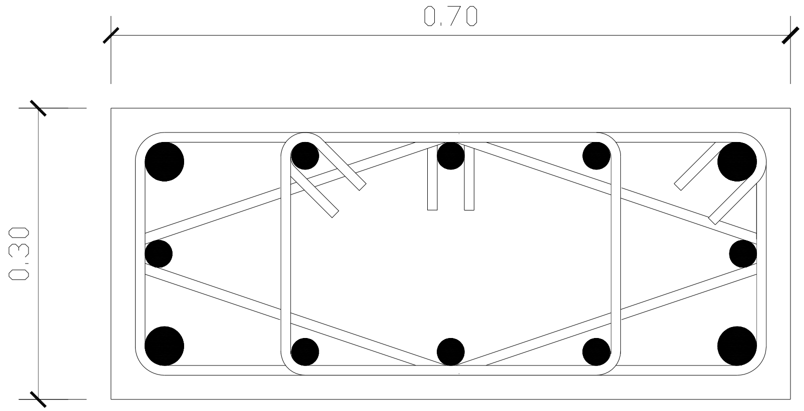
Column C1

Longitudinal: 4Φ16 & 8Φ14

Trans. in h_{cr}=0.70m
Base of ground storey: Φ6/90
All other locations: Φ6/110

Trans. (outside h_{cr}): Φ6/170

Reinforcement of columns



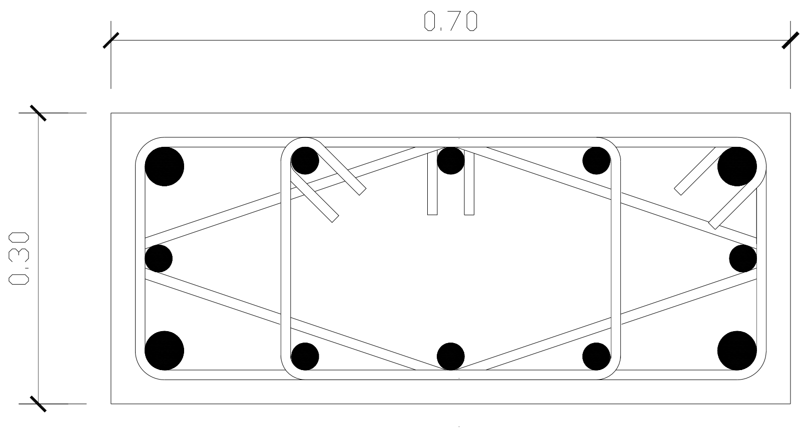
Column C2

Longitudinal: 4Φ16 & 8Φ14

Trans. in h_{cr}=0.70m
Base of ground storey: Φ6/105
All other locations: Φ6/110

Tran. (outside h_{cr}): Φ6/170

Reinforcement of columns



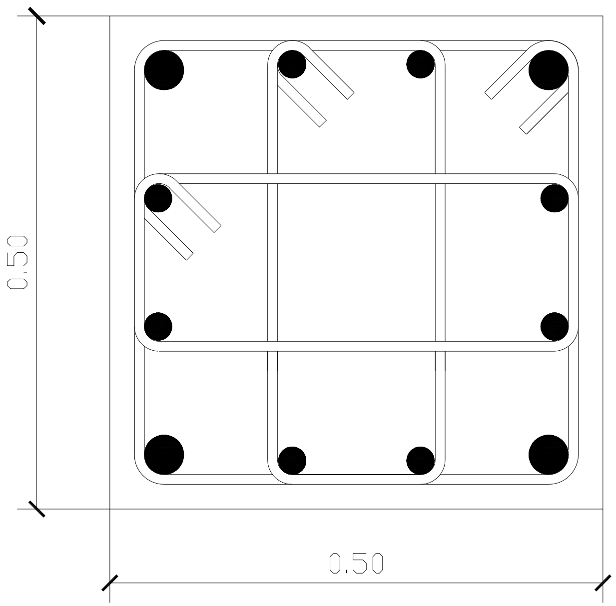
Column C3

Longitudinal: 4Φ16 & 8Φ14

Trans. in h_{cr}=0.70m
Base of ground storey: Φ6/85
All other locations: Φ6/110

Trans. (outside h_{cr}): Φ6/170

Reinforcement of columns



Column C8

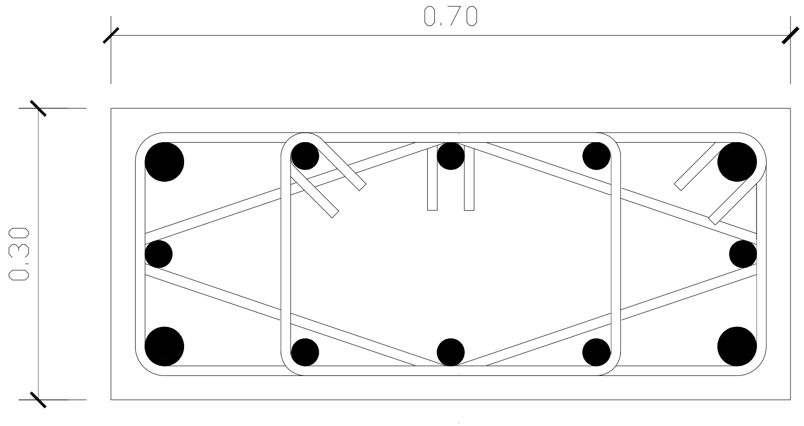
Longitudinal: 4Φ20 & 8Φ14

Trans. at base of ground storey: Φ6/85 in h_{cr}=0.50m

Tran. All other locations: Φ6/110, h_{cr}=0.50m

Tran. (outside h_{cr}): Φ6/170

Reinforcement of columns



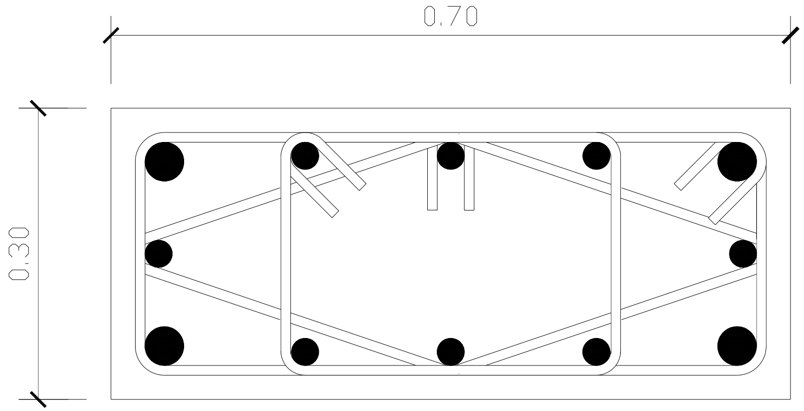
Column C11

Longitudinal: 4Φ16 & 8Φ14

Trans. in h_{cr}=0.70m
Base of ground storey: Φ6/85
All other locations: Φ6/110

Trans. outside h_{cr}
Ground storey: Φ6/120
All other locations: Φ6/170

Reinforcement of columns



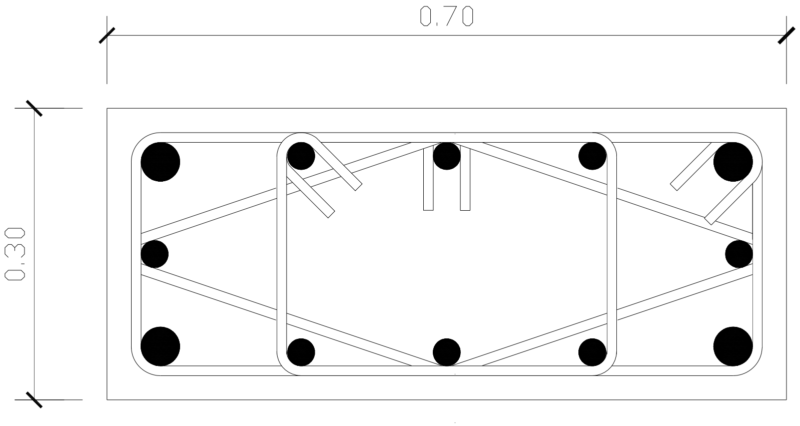
Column C12

Longitudinal: 4Φ16 & 8Φ14

Trans. in h_{cr}=0.70m)
Base of ground storey: Φ6/105
All other locations: Φ6/110

Trans. outside h_{cr}: Φ6/170

Reinforcement of columns



Column C13

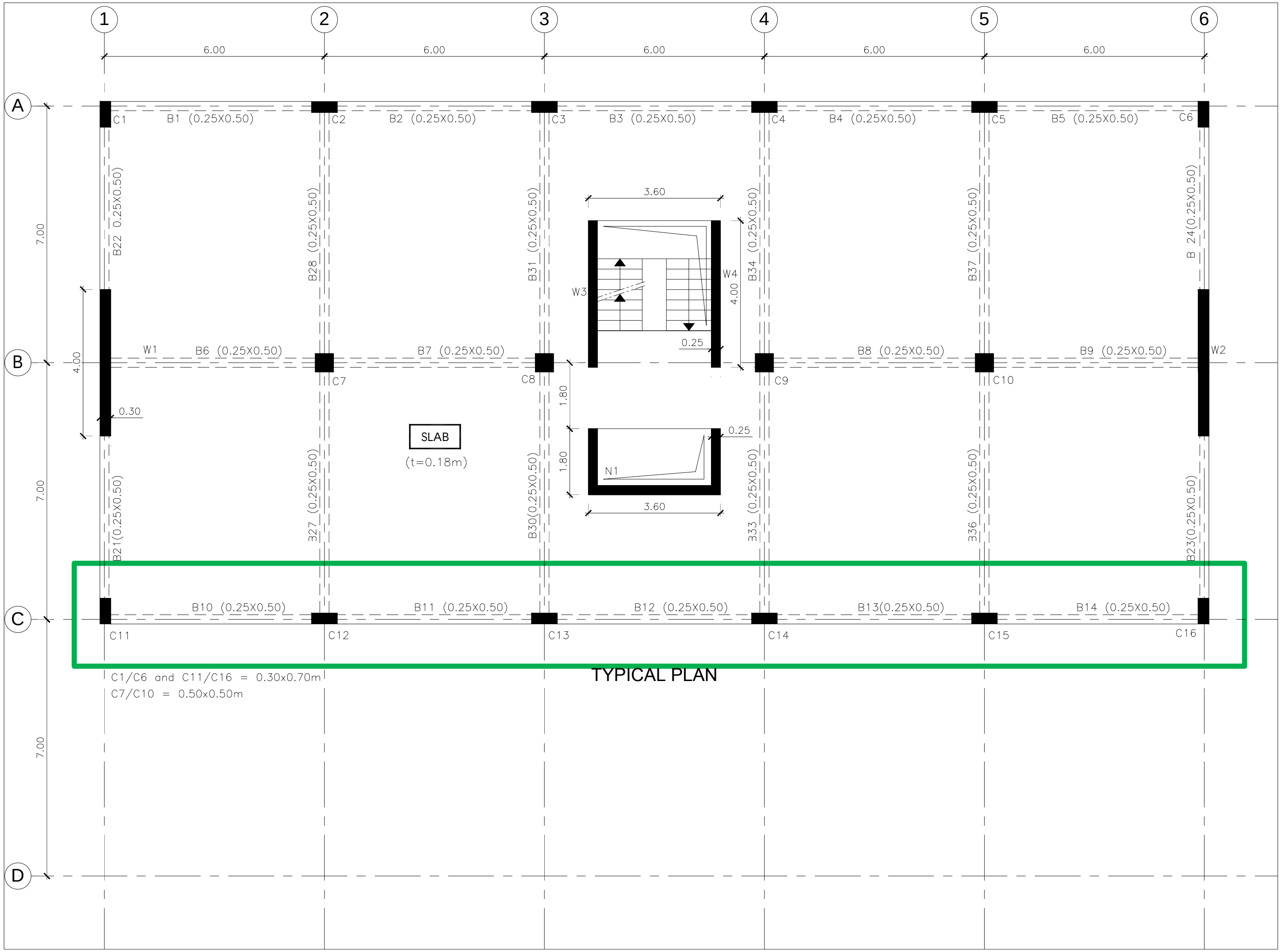
Longitudinal: 4Φ16 & 8Φ14

Trans. in h_{cr}=0.70m
Base of ground storey: Φ6/85
All other locations: Φ6/110

Trans. outside h_{cr}: Φ6/170

Example design of beams in shear

Beam C



1
2
3
4
5
6
A
B
C
D
6.00
7.00
4.00
3.60
1.80
0.25
0.30
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C14
C15
C16
B1 (0.25X0.50)
B2 (0.25X0.50)
B3 (0.25X0.50)
B4 (0.25X0.50)
B5 (0.25X0.50)
B6 (0.25X0.50)
B7 (0.25X0.50)
B8 (0.25X0.50)
B9 (0.25X0.50)
B10 (0.25X0.50)
B11 (0.25X0.50)
B12 (0.25X0.50)
B13(0.25X0.50)
B14 (0.25X0.50)
B21(0.25X0.50)
B22 0.25X0.50)
B 24(0.25X0.50)
B23(0.25X0.50)
B28 (0.25X0.50)
B31 (0.25X0.50)
B34 (0.25X0.50)
B37 (0.25X0.50)
W1
W2
W3
W4
N1
SLAB
(t=0.18m)
C1/C6 and C11/C16 = 0.30x0.70m
C7/C10 = 0.50x0.50m
TYPICAL PLAN

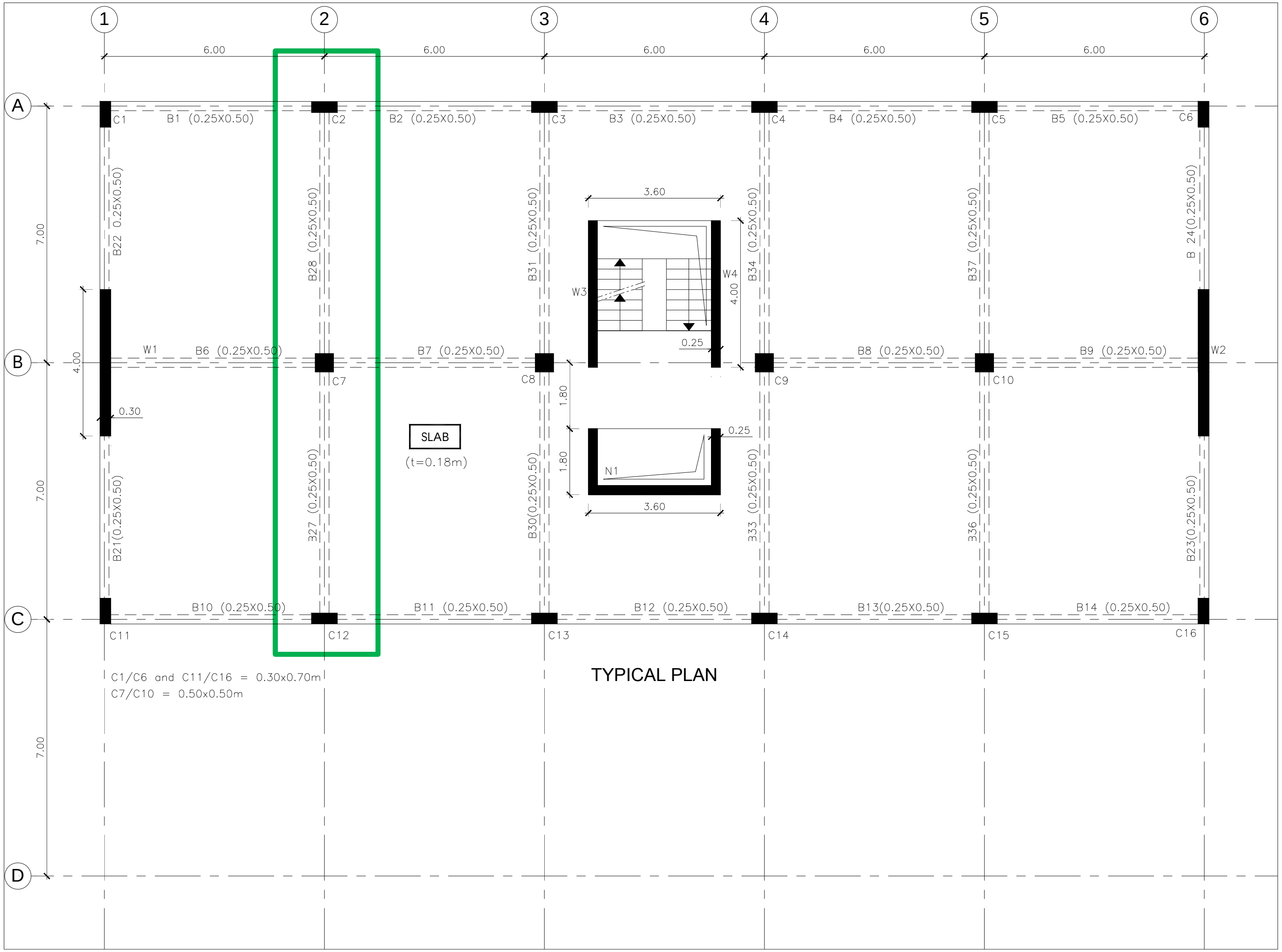
Beam C – storeys 6 to 1


```
  SHEAR FORCES - ULS DESIGN OF TRANSVERSE REINFORCEMENT
+-------------------------------------------------------------------------------+
* Concrete: C25 - Long. Reinforcement: S500 - Stirrups: S500 - Cover: 35(mm)  *
*-------------------------------------------------------------------------------*
  STOREY:  6 * BEAMS:   10   11   12   13   14
*-------------------------------------------------------------------------------*
  SUM OF BEAM/COLUMN DESIGN MOMENT RESISTANCES, SMRd,b/SMRd,c, AROUND JOINT
+-------------------------------------------------------------------------------+
| Beam|                  Beam end & direction of MRd Vector:                    |
|     |   Left End   +y |   Left End   -y |  Right End  +y  |   Right End  -y |
+-----+-------(kNm)------+-------(kNm)------+-------(kNm)------+-------(kNm)------+
*-------------------------------------------------------------------------------*
| 10  |   88.9 /  103.5 |   64.4 /  103.5 |  160.5 /  376.6 |  160.5 /  376.6 |
| 11  |  160.5 /  376.6 |  160.5 /  376.6 |  186.1 /  370.8 |  186.1 /  370.8 |
| 12  |  186.1 /  370.8 |  186.1 /  370.8 |  186.1 /  370.8 |  186.1 /  370.8 |
| 13  |  186.1 /  370.8 |  186.1 /  370.8 |  186.1 /  376.6 |  186.1 /  376.6 |
| 14  |  186.1 /  376.6 |  186.1 /  376.6 |   64.4 /  103.5 |   88.9 /  103.5 |
+-------------------------------------------------------------------------------+
|Beam: 10                                                                       |
|       Seismic Shear (kN)- L End: maxVEd:  62.3 minVEd:   6.2 minV/maxV: 0.10|
|       Seismic Shear (kN)- L End: maxVEd:  64.3 minVEd:   8.2 minV/maxV: 0.13|
|-------------------------------------------------------------------------------|
|Region|Length|Ties design shear|max tie|Prov. ties | strut |  VR,s   | VR,max |
|      |      |Seismic Non-Seis.|spacing| No. Φ   s | angle |provided|provided|
|------+-(m)--+-------(kN)-------+-(mm)--+-----(mm)--+-(deg)-+--(kN)--+--(kN)--|
|L End |  0.50|    56.4     44.1|    96 |  7  8  95 |   25  |  389.7 |  389.7 |
|Centre|  4.60|    52.5     35.9|   330 | 15  8 330 |   21  |  133.2 |  346.8 |
|R End |  0.50|    58.4     44.8|    96 |  7  8  95 |   25  |  389.7 |  389.7 |
+-------------------------------------------------------------------------------+
|Beam: 11                                                                       |
|       Seismic Shear (kN)- L End: maxVEd:  61.2 minVEd:  -1.8 minV/maxV:-0.03|
|       Seismic Shear (kN)- L End: maxVEd:  72.3 minVEd:   9.3 minV/maxV: 0.13|
|-------------------------------------------------------------------------------|
|Region|Length|Ties design shear|max tie|Prov. ties | strut |  VR,s   | VR,max |
|      |      |Seismic Non-Seis.|spacing| No. Φ   s | angle |provided|provided|
|------+-(m)--+-------(kN)-------+-(mm)--+-----(mm)--+-(deg)-+--(kN)--+--(kN)--|
|L End |  0.50|    55.3     42.2|    96 |  7  8  95 |   25  |  389.7 |  389.7 |
|Centre|  4.50|    60.6     37.9|   330 | 15  8 330 |   21  |  133.2 |  346.8 |
|R End |  0.50|    66.4     46.8|    96 |  7  8  95 |   25  |  389.7 |  389.7 |
+-------------------------------------------------------------------------------+
|Beam: 12                                                                       |
|       Seismic Shear (kN)- L End: maxVEd:  69.6 minVEd:  -0.6 minV/maxV:-0.01|
|       Seismic Shear (kN)- L End: maxVEd:  69.6 minVEd:  -0.6 minV/maxV:-0.01|
|-------------------------------------------------------------------------------|
|Region|Length|Ties design shear|max tie|Prov. ties | strut |  VR,s   | VR,max |
|      |      |Seismic Non-Seis.|spacing| No. Φ   s | angle |provided|provided|
|------+-(m)--+-------(kN)-------+-(mm)--+-----(mm)--+-(deg)-+--(kN)--+--(kN)--|
|L End |  0.50|    63.9     43.6|    96 |  7  8  95 |   25  |  389.7 |  389.7 |
|Centre|  4.30|    58.1     34.8|   330 | 15  8 330 |   21  |  133.2 |  346.8 |
|R End |  0.50|    63.9     43.6|    96 |  7  8  95 |   25  |  389.7 |  389.7 |
+-------------------------------------------------------------------------------+
```

Beam C – storeys 0, -1


```
*----------------------------------------------------------------------------*
  STOREY:  0 * BEAMS:   10   11   12   13   14
*----------------------------------------------------------------------------*
  SUM OF BEAM/COLUMN DESIGN MOMENT RESISTANCES, SMRd,b/SMRd,c, AROUND JOINT
+----------------------------------------------------------------------------+
| Beam|                  Beam end & direction of MRd Vector:                 |
|     |   Left End   +y |   Left End   -y |  Right End  +y |   Right End  -y |
+-----+------(kNm)------+------(kNm)------+------(kNm)------+------(kNm)------+
*----------------------------------------------------------------------------*
| 10  |  111.3 /  170.6 |   30.2 /  170.6 |  116.7 /  980.1 |  116.7 /  980.1 |
| 11  |  116.7 /  980.1 |  116.7 /  980.1 |  131.7 /  968.9 |  131.7 /  968.9 |
| 12  |  131.7 /  968.9 |  131.7 /  968.9 |  131.7 /  968.9 |  131.7 /  968.9 |
| 13  |  131.7 /  968.9 |  131.7 /  968.9 |  116.7 /  980.1 |  116.7 /  980.1 |
| 14  |  116.7 /  980.1 |  116.7 /  980.1 |   30.2 /  170.6 |  111.3 /  170.6 |
+----------------------------------------------------------------------------+
|Beam: 10                                                                    |
|----------------------------------------------------------------------------|
|Region|Length|Ties design shear|max tie|Prov. ties | strut |  VR,s  | VR,max |
|      |      |Seismic Non-Seis.|spacing| No. Φ   s | angle |provided|provided|
|------+-(m)--+------(kN)-------+-(mm)--+-----(mm)--+-(deg)-+--(kN)--+--(kN)--|
|L End |  0.50|    70.2     92.8|   330 |  3  8 330 |   21  |  133.2 |  346.8 |
|Centre|  4.60|    58.4     75.0|   330 | 15  8 330 |   21  |  133.2 |  346.8 |
|R End |  0.50|    65.1     85.1|   330 |  3  8 330 |   21  |  133.2 |  346.8 |
+----------------------------------------------------------------------------+
|Beam: 11                                                                    |
|----------------------------------------------------------------------------|
|Region|Length|Ties design shear|max tie|Prov. ties | strut |  VR,s  | VR,max |
|      |      |Seismic Non-Seis.|spacing| No. Φ   s | angle |provided|provided|
|------+-(m)--+------(kN)-------+-(mm)--+-----(mm)--+-(deg)-+--(kN)--+--(kN)--|
|L End |  0.50|    70.5     87.6|   330 |  3  8 330 |   21  |  133.2 |  346.8 |
|Centre|  4.50|    60.6     72.5|   330 | 15  8 330 |   21  |  133.2 |  346.8 |
|R End |  0.50|    72.3     90.3|   330 |  3  8 330 |   21  |  133.2 |  346.8 |
+----------------------------------------------------------------------------+
|Beam: 12                                                                    |
|----------------------------------------------------------------------------|
|Region|Length|Ties design shear|max tie|Prov. ties | strut |  VR,s  | VR,max |
|      |      |Seismic Non-Seis.|spacing| No. Φ   s | angle |provided|provided|
|------+-(m)--+------(kN)-------+-(mm)--+-----(mm)--+-(deg)-+--(kN)--+--(kN)--|
|L End |  0.50|    72.0     89.9|   330 |  3  8 330 |   21  |  133.2 |  346.8 |
|Centre|  4.30|    60.1     71.9|   330 | 15  8 330 |   21  |  133.2 |  346.8 |
|R End |  0.50|    72.0     89.9|   330 |  3  8 330 |   21  |  133.2 |  346.8 |
+----------------------------------------------------------------------------+
```

Beam 2



1
2
3
4
5
6
6.00
A
B
C
D
C1
B1 (0.25X0.50)
C2
B2 (0.25X0.50)
C3
B3 (0.25X0.50)
C4
B4 (0.25X0.50)
C5
B5 (0.25X0.50)
C6
B22 0.25X0.50)
B28 (0.25X0.50)
B31 (0.25X0.50)
B34 (0.25X0.50)
B37 (0.25X0.50)
B 24(0.25X0.50)
3.60
W3
W4
4.00
0.25
7.00
W1
B6 (0.25X0.50)
B7 (0.25X0.50)
B8 (0.25X0.50)
B9 (0.25X0.50)
W2
C7
C8
C9
C10
0.30
1.80
SLAB
(t=0.18m)
N1
B21(0.25X0.50)
327 (0.25X0.50)
B30(0.25X0.50)
333 (0.25X0.50)
336 (0.25X0.50)
B23(0.25X0.50)
B10 (0.25X0.50)
B11 (0.25X0.50)
B12 (0.25X0.50)
B13(0.25X0.50)
B14 (0.25X0.50)
C11
C12
C13
C14
C15
C16
C1/C6 and C11/C16 = 0.30x0.70m
C7/C10 = 0.50x0.50m
TYPICAL PLAN

Beam 2 – storeys 6 to 1

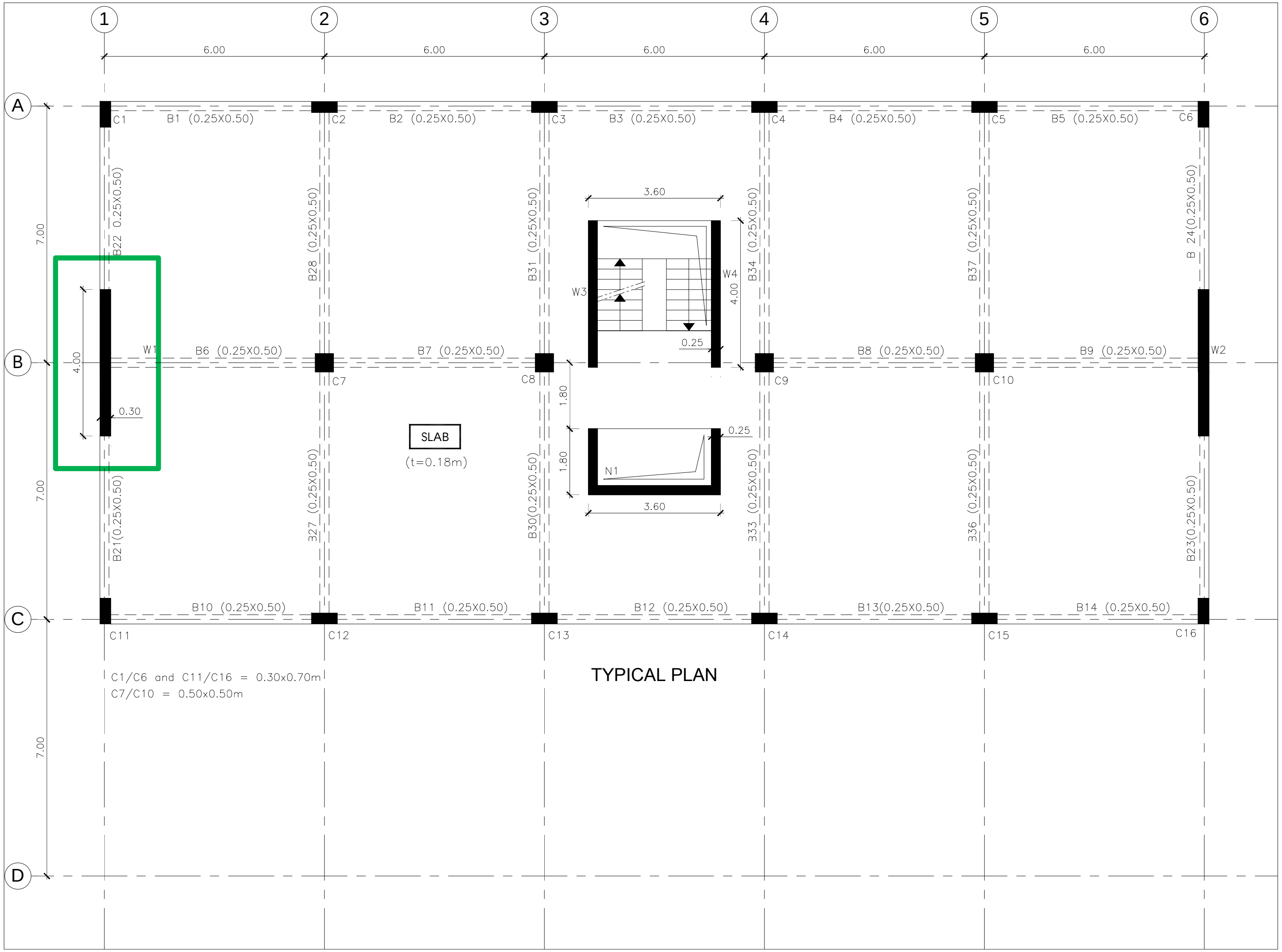

```
+------------------------------------------------------------------------------+
  SHEAR FORCES - ULS DESIGN OF TRANSVERSE REINFORCEMENT
+------------------------------------------------------------------------------+
* Concrete: C25 - Long. Reinforcement: S500 - Stirrups: S500 - Cover: 35(mm)   *
*------------------------------------------------------------------------------*
  STOREY:  6 * BEAMS:   28   27
*------------------------------------------------------------------------------*
  SUM OF BEAM/COLUMN DESIGN MOMENT RESISTANCES, SMRd,b/SMRd,c, AROUND JOINT
+------------------------------------------------------------------------------+
| Beam|                  Beam end & direction of MRd Vector:                     |
|     |   Left End   +y |   Left End   -y |  Right End  +y  |   Right End  -y |
+-----+-------(kNm)------+-------(kNm)------+-------(kNm)------+-------(kNm)------+
*------------------------------------------------------------------------------*
| 28  |  113.5 /  107.8 |   64.9 /  107.8 |  312.3 /  309.5 |  312.3 /  309.5 |
| 27  |  312.3 /  309.5 |  312.3 /  309.5 |   64.9 /  309.5 |  113.5 /  309.5 |
+------------------------------------------------------------------------------+
|Beam: 28                                                                      |
|       Seismic Shear (kN)- L End: maxVEd: 114.8 minVEd:  36.4 minV/maxV: 0.32|
|       Seismic Shear (kN)- L End: maxVEd: 151.5 minVEd:  73.1 minV/maxV: 0.48|
|------------------------------------------------------------------------------|
|Region|Length|Ties design shear|max tie|Prov. ties | strut |  VR,s  | VR,max |
|      |      |Seismic Non-Seis.|spacing| No. Φ   s | angle |provided|provided|
|------+-(m)--+-------(kN)--------+-(mm)--+------(mm)--+-(deg)-+--(kN)--+--(kN)--|
|L End |  0.50|   101.4    110.2|    96 |  7  8  95 |   25  |  389.7 |  389.7 |
|Centre|  5.15|   124.7    113.4|   330 | 17  8 330 |   21  |  133.2 |  346.8 |
|R End |  0.50|   138.1    133.8|    96 |  7  8  95 |   25  |  389.7 |  389.7 |
+------------------------------------------------------------------------------+
|Beam: 27                                                                      |
|       Seismic Shear (kN)- L End: maxVEd: 153.4 minVEd:  74.0 minV/maxV: 0.48|
|       Seismic Shear (kN)- L End: maxVEd: 113.9 minVEd:  34.6 minV/maxV: 0.30|
|------------------------------------------------------------------------------|
|Region|Length|Ties design shear|max tie|Prov. ties | strut |  VR,s  | VR,max |
|      |      |Seismic Non-Seis.|spacing| No. Φ   s | angle |provided|provided|
|------+-(m)--+-------(kN)--------+-(mm)--+------(mm)--+-(deg)-+--(kN)--+--(kN)--|
|L End |  0.50|   139.9    135.0|    96 |  7  8  95 |   25  |  389.7 |  389.7 |
|Centre|  5.15|   126.5    114.7|   330 | 17  8 330 |   21  |  133.2 |  346.8 |
|R End |  0.50|   100.5    109.0|    96 |  7  8  95 |   25  |  389.7 |  389.7 |
+------------------------------------------------------------------------------+
```

Beam 2 – storeys 0, -1

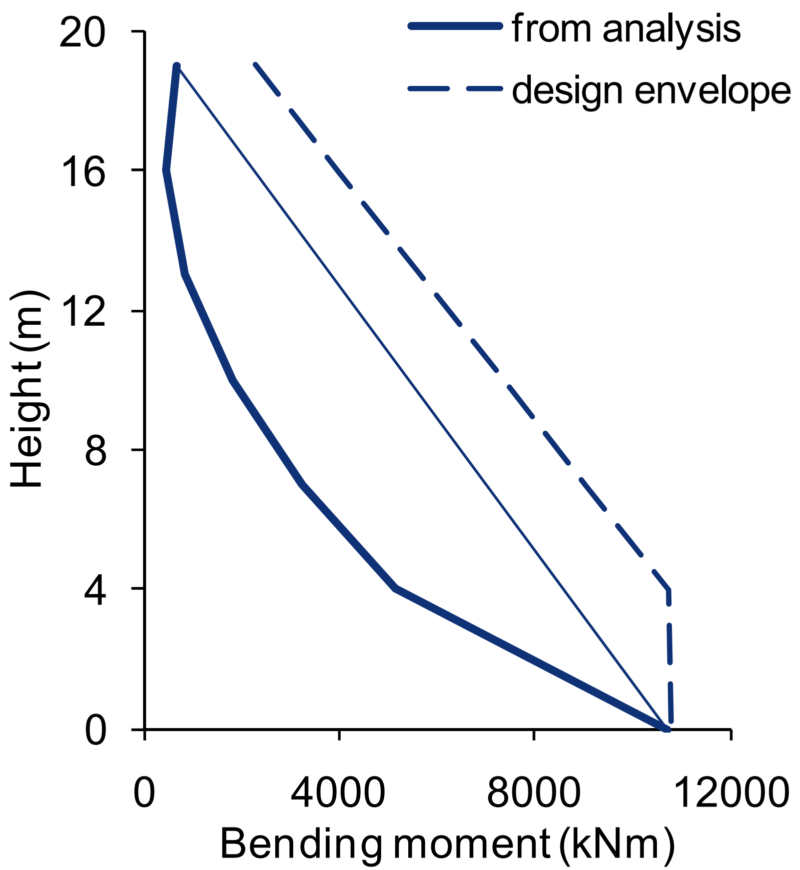

```
*-------------------------------------------------------------------------------*
  STOREY:   0 * BEAMS:   28   27   26
*-------------------------------------------------------------------------------*
  SUM OF BEAM/COLUMN DESIGN MOMENT RESISTANCES, SMRd,b/SMRd,c, AROUND JOINT
+-------------------------------------------------------------------------------+
| Beam|                 Beam end & direction of MRd Vector:                    |
|     |   Left End    +y |   Left End    -y |  Right End   +y |   Right End  -y |
+-----+-------(kNm)------+-------(kNm)------+-------(kNm)------+-------(kNm)------+
*-------------------------------------------------------------------------------*
| 28  |  174.0 /  181.6 |   30.3 /  181.6 |  177.0 /  844.1 |  177.0 /  844.1 |
| 27  |  177.0 /  844.1 |  177.0 /  844.1 |  188.6 /  617.4 |  208.8 /  617.4 |
| 26  |  188.6 /  617.4 |  208.8 /  617.4 |   30.3 /    0.0 |  158.2 /    0.0 |
+-------------------------------------------------------------------------------+
|Beam: 28                                                                       |
|-------------------------------------------------------------------------------|
|Region|Length|Ties design shear|max tie|Prov. ties | strut |  VR,s   | VR,max |
|      |      |Seismic Non-Seis.|spacing| No. Φ   s | angle |provided|provided|
|------+-(m)--+-------(kN)-------+-(mm)--+-----(mm)--+-(deg)-+--(kN)--+--(kN)--|
|L End |  0.50|    87.9    126.9|   330 |  3   8 330 |   21   |  133.2 |  346.8 |
|Centre|  5.15|    74.5    106.6|   330 | 17   8 330 |   21   |  133.2 |  346.8 |
|R End |  0.50|    81.4    117.1|   330 |  3   8 330 |   21   |  133.2 |  346.8 |
+-------------------------------------------------------------------------------+
|Beam: 27                                                                       |
|-------------------------------------------------------------------------------|
|Region|Length|Ties design shear|max tie|Prov. ties | strut |  VR,s   | VR,max |
|      |      |Seismic Non-Seis.|spacing| No. Φ   s | angle |provided|provided|
|------+-(m)--+-------(kN)-------+-(mm)--+-----(mm)--+-(deg)-+--(kN)--+--(kN)--|
|L End |  0.50|    81.8    117.6|   330 |  3   8 330 |   21   |  133.2 |  346.8 |
|Centre|  5.15|    74.2    106.1|   330 | 17   8 330 |   21   |  133.2 |  346.8 |
|R End |  0.50|    87.7    126.4|   330 |  3   8 330 |   21   |  133.2 |  346.8 |
+-------------------------------------------------------------------------------+
|Beam: 26                                                                       |
|-------------------------------------------------------------------------------|
|Region|Length|Ties design shear|max tie|Prov. ties | strut |  VR,s   | VR,max |
|      |      |Seismic Non-Seis.|spacing| No. Φ   s | angle |provided|provided|
|------+-(m)--+-------(kN)-------+-(mm)--+-----(mm)--+-(deg)-+--(kN)--+--(kN)--|
|L End |  0.50|    82.4    121.7|   330 |  3   8 330 |   21   |  133.2 |  346.8 |
|Centre|  5.70|    69.5    102.0|   330 | 19   8 330 |   21   |  133.2 |  346.8 |
|R End |  0.50|    82.9    122.4|   330 |  3   8 330 |   21   |  133.2 |  346.8 |
```

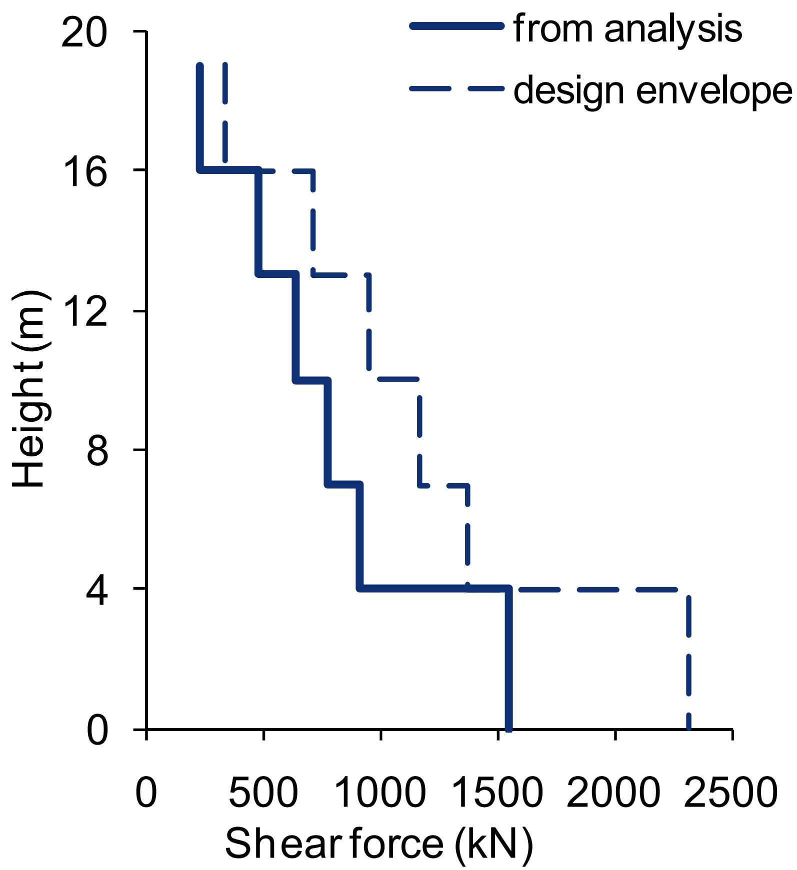
Design of walls

Wall 1


1
2
3
4
5
6
A
B
C
D
6.00
7.00
4.00
0.30
3.60
1.80
0.25
W1
W2
W3
W4
N1
SLAB
(t=0.18m)
C1/C6 and C11/C16 = 0.30x0.70m
C7/C10 = 0.50x0.50m
TYPICAL PLAN

Wall 1


from analysis
design envelope
Height (m)
20
16
12
8
4
0
0
4000
8000
12000
Bending moment (kNm)


from analysis
design envelope
Height (m)
20
16
12
8
4
0
0
500
1000
1500
2000
2500
Shear force (kN)

Wall 1

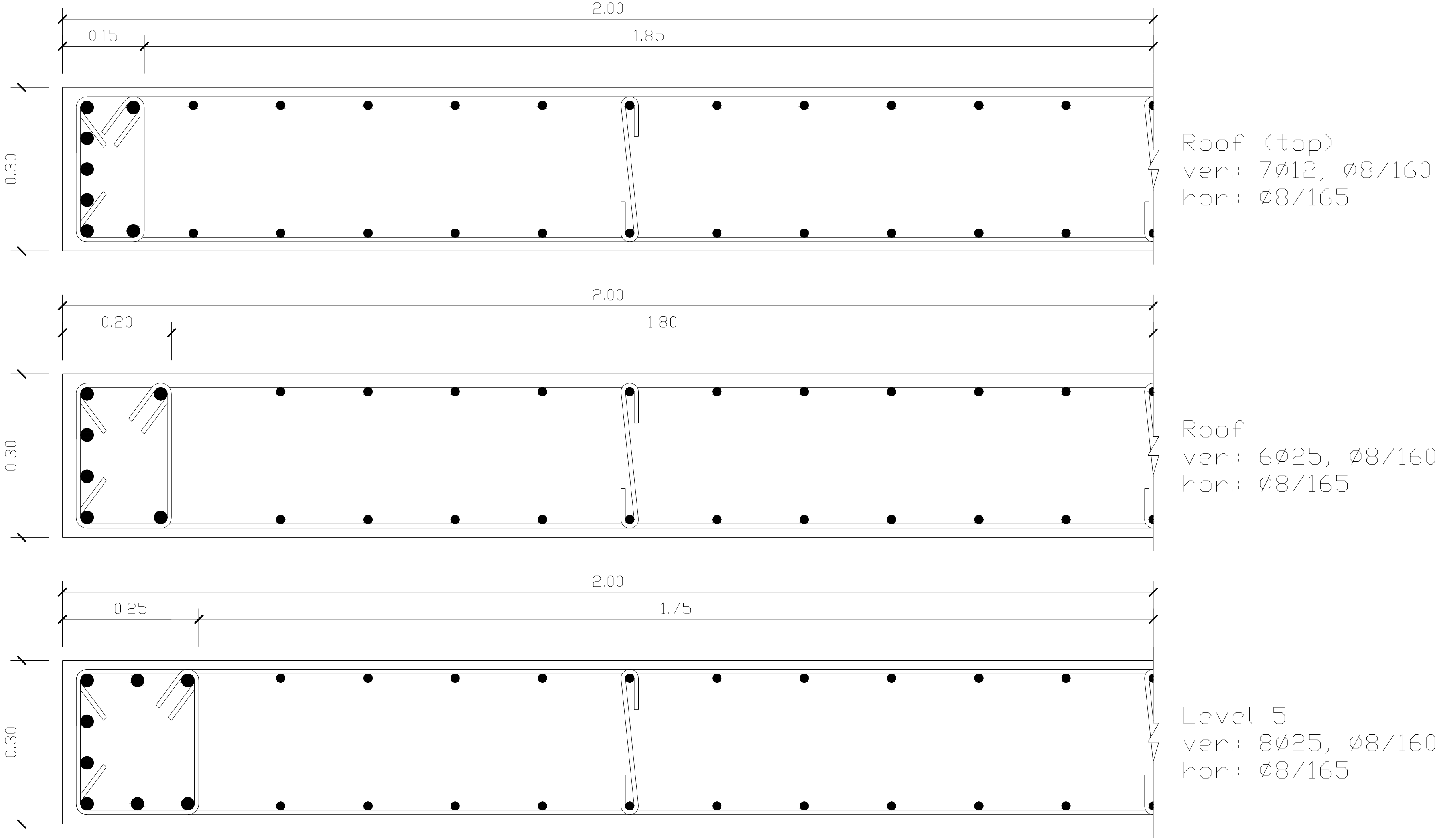
DESIGN IN SHEAR W/O SHORT-SHEAR-SPAN EFFECTS (Web diagonal compression/tension)

Storey and location	Design shear maxVEd (kN)	Horizontal bars dia. (mm)	legs	spacing-sh maximum (mm)	spacing-sh provided (mm)	strut angle (deg)	Resistance VR,s (kN)	Resistance VR,max (kN)
6 Along	351.3	8	2	165	165	21	2119.2	2979.3
5 Along	721.9	8	2	165	165	21	2119.2	2979.3
4 Along	958.7	8	2	165	165	21	2119.2	2979.3
3 Along	1179.1	8	2	165	165	21	2119.2	2979.3
2 Along	1379.0	8	2	165	165	21	2119.2	2979.3
1 Along	2328.7	8	2	165	150	21	2331.2	2979.3

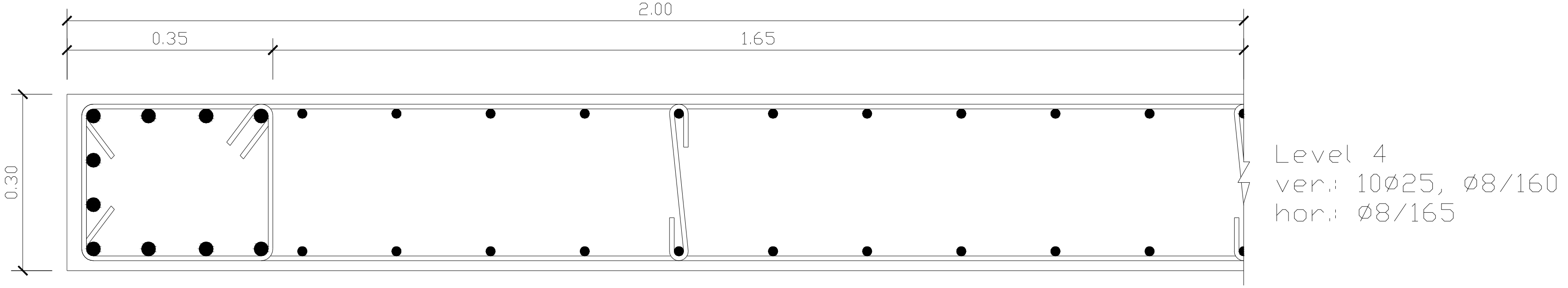
VERTICAL / HORIZONTAL / HOOP REINFORCEMENT (Story and base of above)

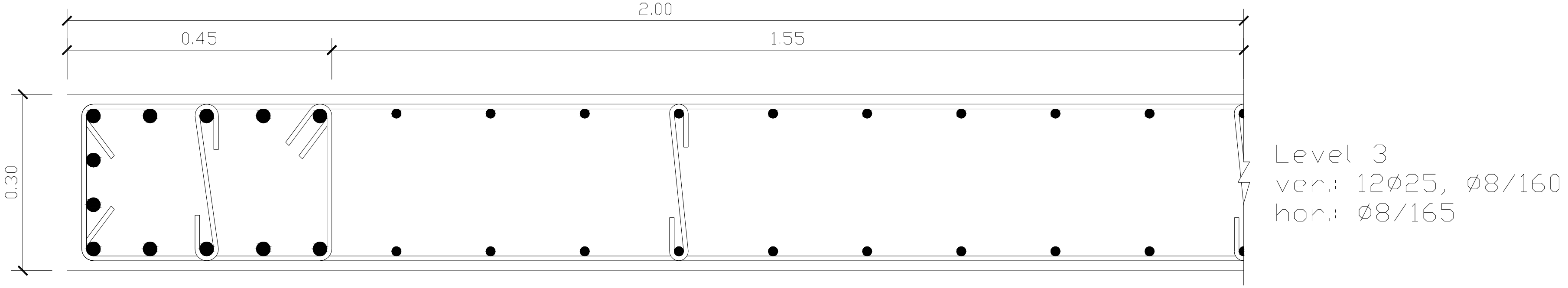
	BOUNDARY ELEMENTS									WEB REINFORCEMENT					Addit
STOR	Dimens. (m)	Vertical bars dia (mm)	tot	end	side	Hoops dia. (mm)	sh	omega-wd Req	Prov	Vertical dia. (mm)	sv	No.	Horizontal dia. (mm)	sh	Joint reinf (mm2)
6	0.15X0.30	12	7	5	1	8	140	0.00	0.26	8	160	23	8	165	0
5	0.20X0.30	25	6	4	1	8	140	0.00	0.22	8	160	23	8	165	0
4	0.25X0.30	25	8	4	2	8	140	0.00	0.22	8	160	22	8	165	0
3	0.35X0.30	25	10	4	3	8	140	0.00	0.19	8	160	21	8	165	0
2	0.45X0.30	25	12	4	4	8	140	0.00	0.19	8	160	19	8	165	0
1	0.60X0.30	25	12	4	4	8	140	0.00	0.19	8	160	18	8	150	0
0	0.60X0.30	25	12	4	4	8	140	0.00	0.19	8	160	18	8	150	0

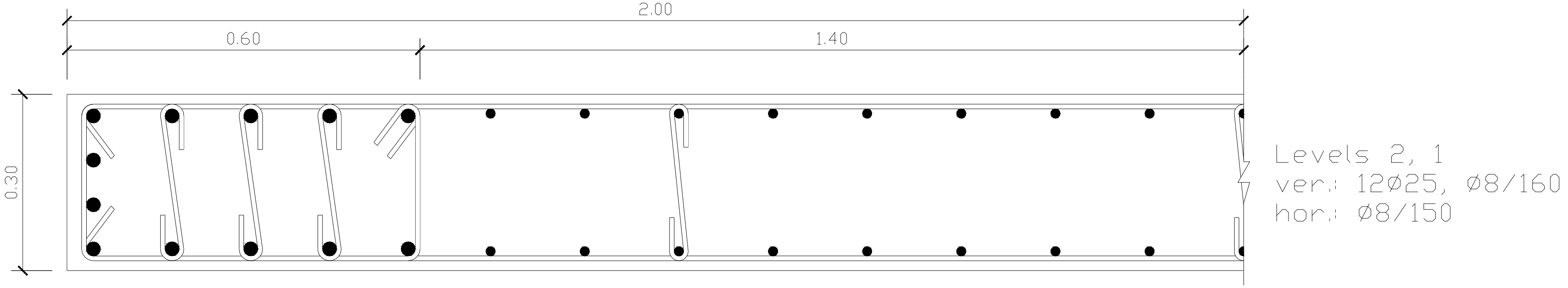
Wall 1


2.00
0.15
1.85
0.30
Roof (top)
ver.: 7Ø12, Ø8/160
hor.: Ø8/165
2.00
0.20
1.80
0.30
Roof
ver.: 6Ø25, Ø8/160
hor.: Ø8/165
2.00
0.25
1.75
0.30
Level 5
ver.: 8Ø25, Ø8/160
hor.: Ø8/165

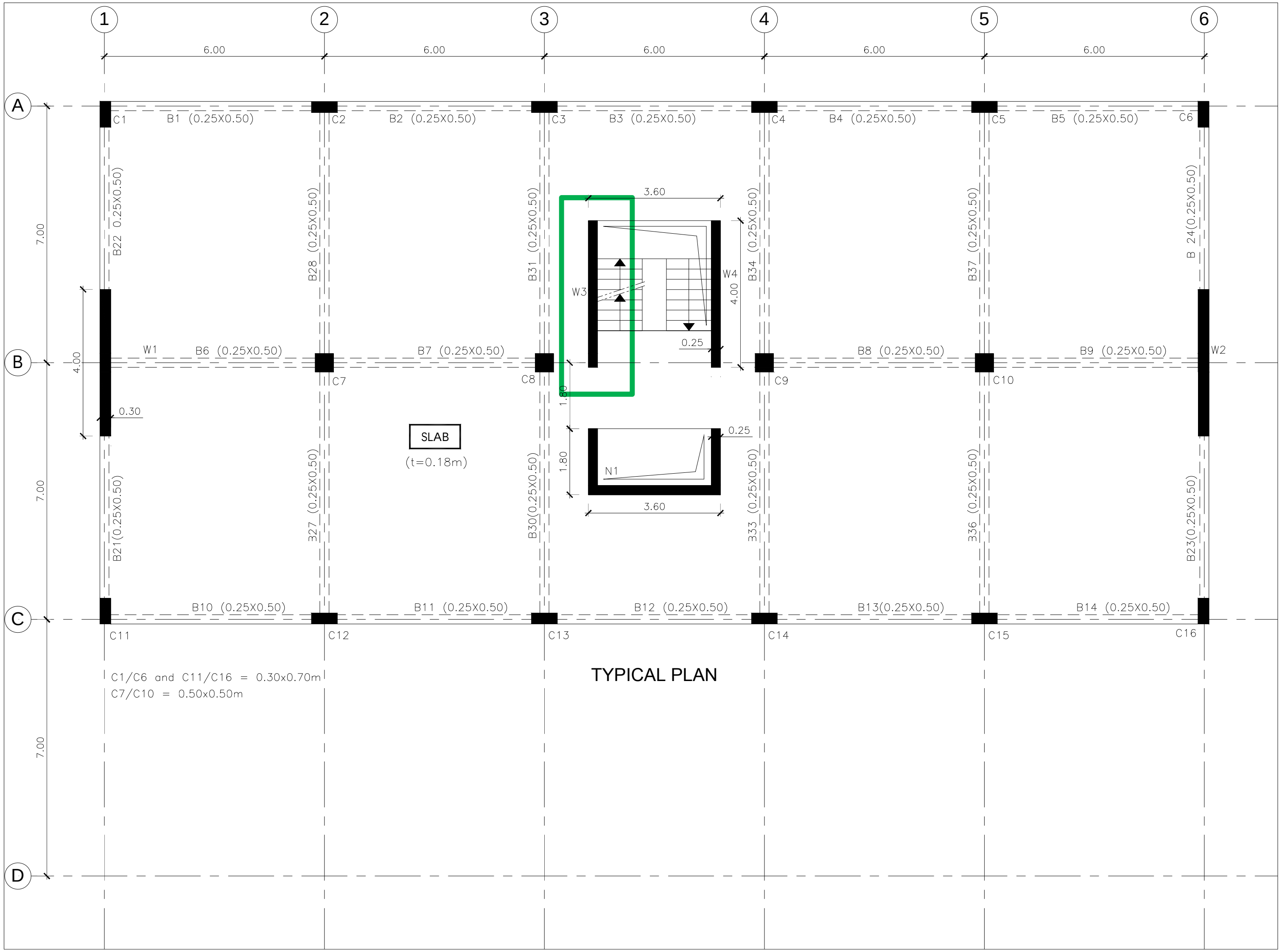
Wall 1


2.00
0.35
1.65
0.30
Level 4
ver.: 10Ø25, Ø8/160
hor.: Ø8/165

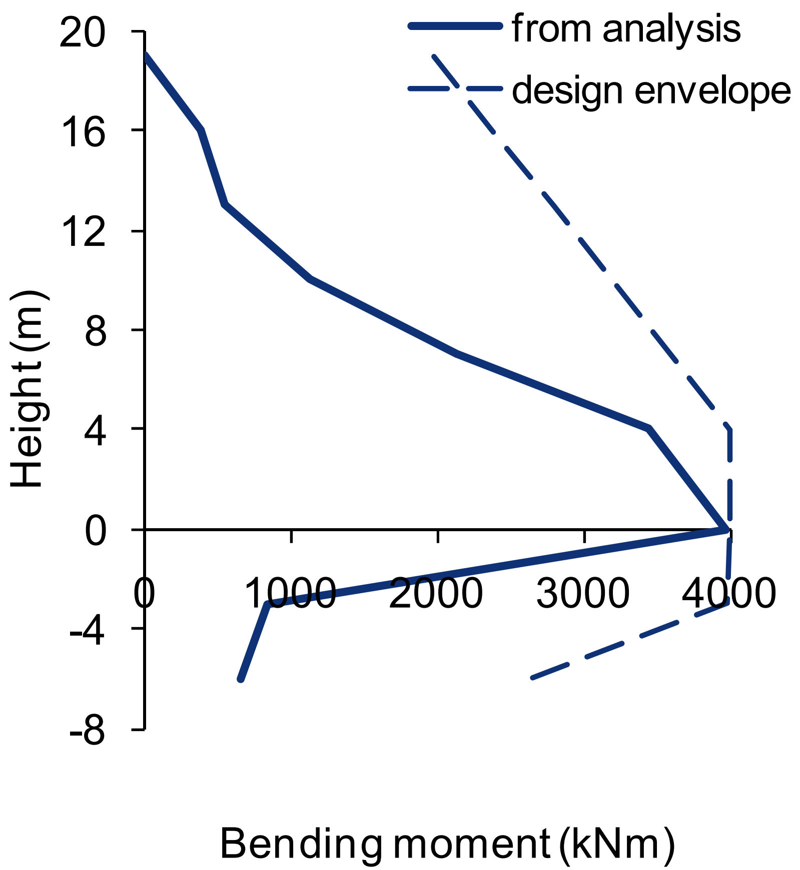

2.00
0.45
1.55
0.30
Level 3
ver.: 12Ø25, Ø8/160
hor.: Ø8/165


2.00
0.60
1.40
0.30
Levels 2, 1
ver.: 12Ø25, Ø8/160
hor.: Ø8/150

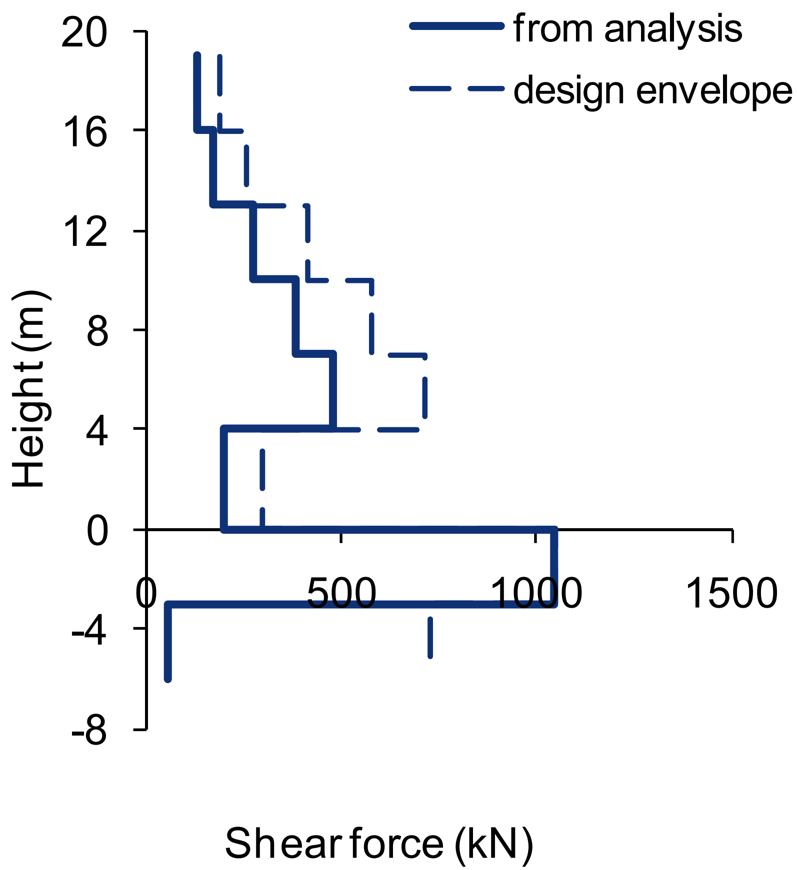
Wall 3


1
2
3
4
5
6
6.00
A
B
C
D
7.00
4.00
3.60
0.25
1.80
0.30
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C14
C15
C16
B1 (0.25X0.50)
B2 (0.25X0.50)
B3 (0.25X0.50)
B4 (0.25X0.50)
B5 (0.25X0.50)
B6 (0.25X0.50)
B7 (0.25X0.50)
B8 (0.25X0.50)
B9 (0.25X0.50)
B10 (0.25X0.50)
B11 (0.25X0.50)
B12 (0.25X0.50)
B13(0.25X0.50)
B14 (0.25X0.50)
W1
W2
W3
W4
N1
SLAB
(t=0.18m)
C1/C6 and C11/C16 = 0.30x0.70m
C7/C10 = 0.50x0.50m
TYPICAL PLAN

Wall 3



from analysis
design envelope
20
16
12
8
4
0
-4
-8
Height (m)
0
1000
2000
3000
4000
Bending moment (kNm)



from analysis
design envelope
20
16
12
8
4
0
-4
-8
Height (m)
0
500
1000
1500
Shear force (kN)

Wall 3

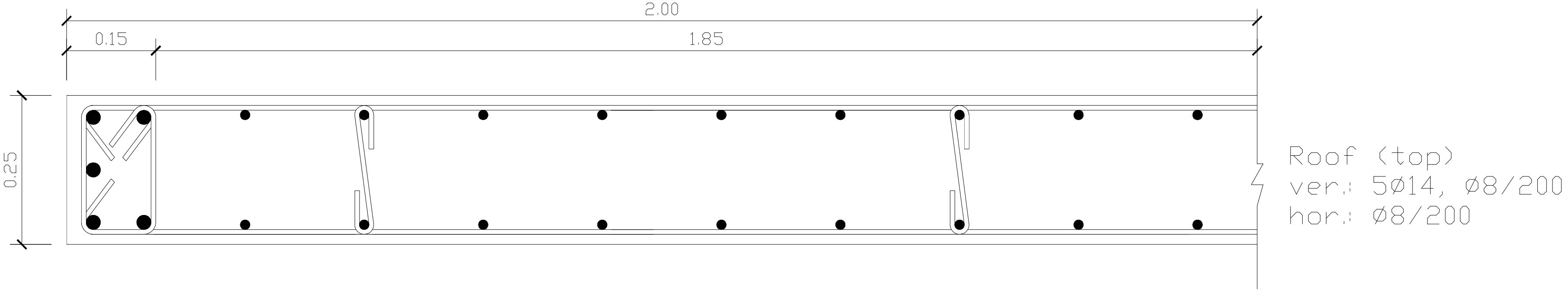
DESIGN IN SHEAR W/O SHORT-SHEAR-SPAN EFFECTS (Web diagonal compression/tension)

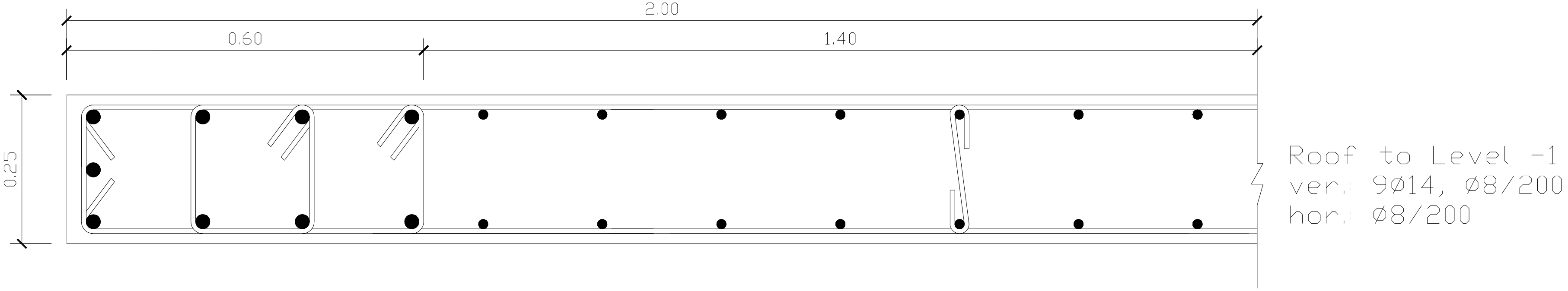
Storey and location	Design shear maxVEd (kN)	Horizontal bars dia. (mm)	legs	spacing-sh maximum (mm)	spacing-sh provided (mm)	strut angle (deg)	Resistance VR,s (kN)	Resistance VR,max (kN)
6 Along	197.2	8	2	200	200	21	1748.4	2482.8
5 Along	259.1	8	2	200	200	21	1748.4	2482.8
4 Along	419.2	8	2	200	200	21	1748.4	2482.8
3 Along	583.7	8	2	200	200	21	1748.4	2482.8
2 Along	719.8	8	2	200	200	21	1748.4	2482.8
1 Along	300.7	8	2	200	200	21	1748.4	2482.8
0 Along	1051.9	8	2	200	200	21	1748.4	2482.8
-1 Along	729.4	8	2	200	200	21	1748.4	2482.8

VERTICAL / HORIZONTAL / HOOP REINFORCEMENT (Story and base of above)

STOR	BOUNDARY ELEMENTS Dimens. (m)	Vertical bars dia (mm)	tot	end	side	Hoops dia. (mm)	sh (mm)	omega-wd Req	omega-wd Prov	WEB REINFORCEMENT Vertical dia. (mm)	sv (mm)	No.	Horizontal dia. (mm)	sh (mm)	Addit Joint reinf (mm2)
6	0.15X0.25	14	5	3	1	8	105	0.00	0.24	8	200	19	8	200	0
5	0.60X0.25	14	9	3	3	8	105	0.00	0.24	8	200	14	8	200	0
4	0.60X0.25	14	9	3	3	8	105	0.00	0.24	8	200	14	8	200	0
3	0.60X0.25	14	9	3	3	8	105	0.00	0.24	8	200	14	8	200	0
2	0.60X0.25	14	9	3	3	8	105	0.00	0.24	8	200	14	8	200	0
1	0.60X0.25	14	9	3	3	8	105	0.00	0.24	8	200	14	8	200	0
0	0.60X0.25	14	9	3	3	8	105	0.00	0.24	8	200	14	8	200	0
-1	0.60X0.25	14	9	3	3	8	105	0.00	0.24	8	200	14	8	200	0
-2	0.60X0.25	14	9	3	3	8	105	0.00	0.24	8	200	14	8	200	0

Wall 3


2.00
0.15
1.85
0.25
Roof (top)
ver.: 5Ø14, Ø8/200
hor.: Ø8/200


2.00
0.60
1.40
0.25
Roof to Level -1
ver.: 9Ø14, Ø8/200
hor.: Ø8/200

Wall 3


```
     FOOTING OF WALL :    3
Undr. shear strength in seismic design sitation: 270kPa in Eqs.6.10a/b: 300kPa
Friction angle & cohesion under drained conditions for Eqs.6.10a/b: 20deg,50kPa
+------------------------------------------------------------------------------+
|footing depth h(m): 1.00|Footing plan dimension(m): //y by=4.00  //z bz=5.00 |
|found. depth (m): 1.00  |Member section outline(m): //y cy=3.60  //z cz=4.00 |
|                        |Member axis eccentricity(m): //y ay=0.00 //z az=0.00|
+------------------------------------------------------------------------------+
 FOUNDATION DESIGN FORCES AT FOOTING CENTRE - SOIL BEARING PRESSURE & CAPACITY
+------------------------------------------------------------------------------+
|   Combination    |Cap-Des|  N     My ey/by  Vy   Mz ez/bz  Vz   Soil Bearing |
|    of Actions    |magnif.|total                                press./capacity|
+------------------+-------+-(kN)-(kNm)------(kN)-(kNm)-----(kN)-------(kPa)----+
|EN1990 Eq. 6.10a*|   -   | 5280    0 0.000   0    4 0.000   2    264.1/1814.4|
|EN1990 Eq. 6.10b*|   -   | 4790    0 0.000   0    4 0.000   2    239.6/1814.4|
|G+ψ2Q+E+X/+Y/maxN| 2.155 | 3674   79 0.005  36 2629 0.143 265    260.3/1663.7|
|G+ψ2Q+E-X/+Y/maxN| 2.155 | 3674   79 0.005  36 2629 0.143 265    260.3/1663.7|
|G+ψ2Q+E+X/-Y/maxN| 2.182 | 3674   80 0.006  37 2668 0.145 265    261.9/1662.2|
|G+ψ2Q+E-X/-Y/maxN| 2.182 | 3674   80 0.006  37 2668 0.145 265    261.9/1662.2|
|G+ψ2Q+E+X/+Y/minN| 2.155 | 3674   79 0.005  36 2629 0.143 265    260.3/1663.7|
|G+ψ2Q+E-X/+Y/minN| 2.155 | 3674   79 0.005  36 2629 0.143 265    260.3/1663.7|
|G+ψ2Q+E+X/-Y/minN| 2.182 | 3674   80 0.006  37 2668 0.145 265    261.9/1662.2|
|G+ψ2Q+E-X/-Y/minN| 2.182 | 3674   80 0.006  37 2668 0.145 265    261.9/1662.2|
+------------------------------------------------------------------------------+
*Note: The most unfavourable outcome of the application of 6.10a/6.10b applies.
+------------------------------------------------------------------------------+
```

Wall 3

ULS DESIGN OF FOOTING IN SHEAR & PUNCHING SHEAR

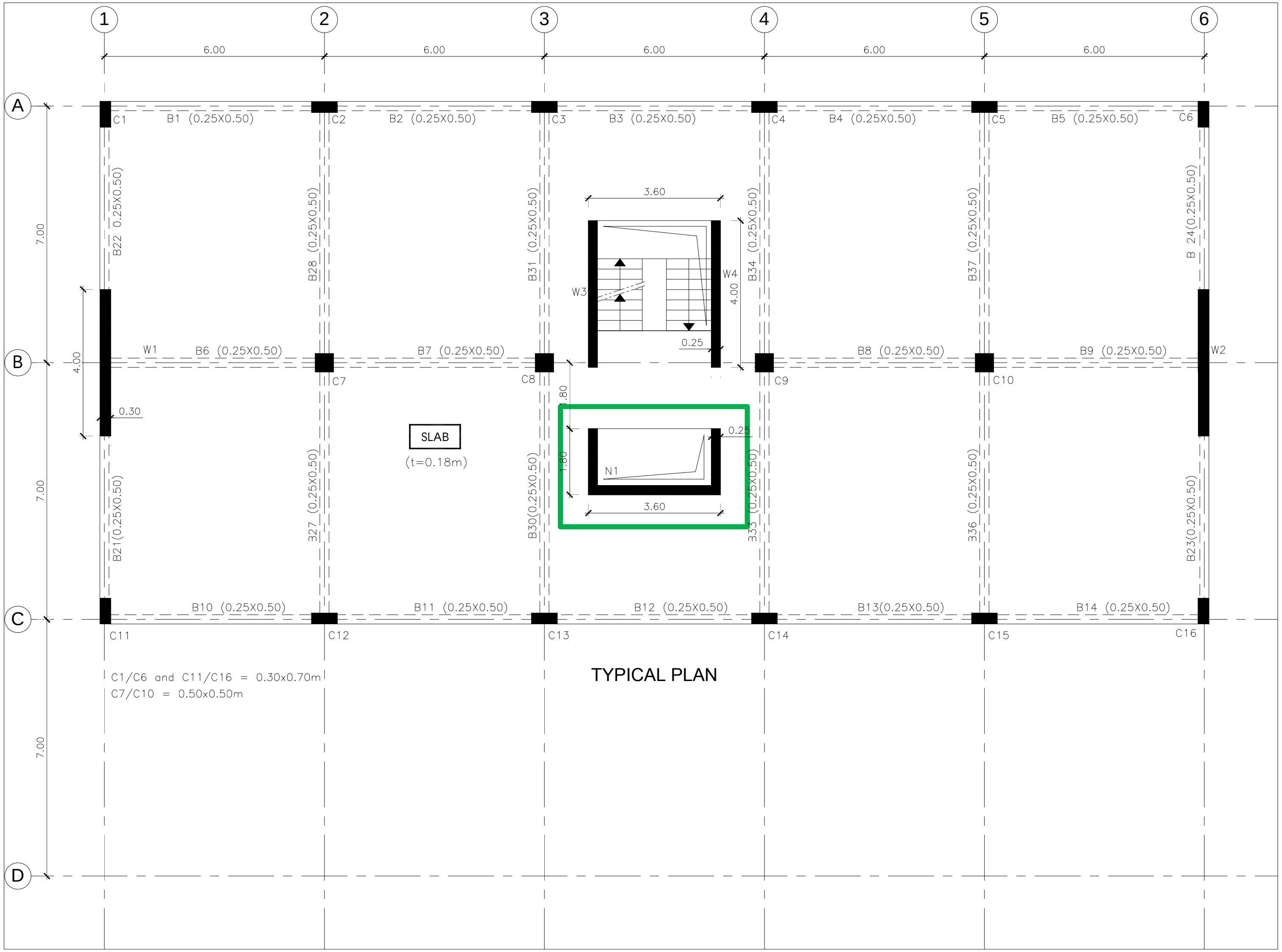
Combination of Actions	Shear stress vEd sect.//y vEdy/bzd (kPa)	Shear stress vEd sect.//z VEdz/byd (kPa)	Shear Resist. vRd,c (kPa)	Punching shear at distance av: max stress maxvEd (kPa)	Punching shear at distance av: av: crit. distance (m)	Punching shear at distance av: Resistance (2d/av)vRd (kPa)
EN1990 Eq. 6.10a*	0.0	0.0	309.3	0.0	0.5	0.0
EN1990 Eq. 6.10b*	0.0	0.0	309.3	0.0	0.5	0.0
G+ψ2Q+E+X/+Y/maxN	0.0	0.0	309.3	0.0	0.5	0.0
G+ψ2Q+E-X/+Y/maxN	0.0	0.0	309.3	0.0	0.5	0.0
G+ψ2Q+E+X/-Y/maxN	0.0	0.0	309.3	0.0	0.5	0.0
G+ψ2Q+E-X/-Y/maxN	0.0	0.0	309.3	0.0	0.5	0.0
G+ψ2Q+E+X/+Y/minN	0.0	0.0	309.3	0.0	0.5	0.0
G+ψ2Q+E-X/+Y/minN	0.0	0.0	309.3	0.0	0.5	0.0
G+ψ2Q+E+X/-Y/minN	0.0	0.0	309.3	0.0	0.5	0.0
G+ψ2Q+E-X/-Y/minN	0.0	0.0	309.3	0.0	0.5	0.0

*Note: The most unfavourable outcome of the application of 6.10a/6.10b applies.

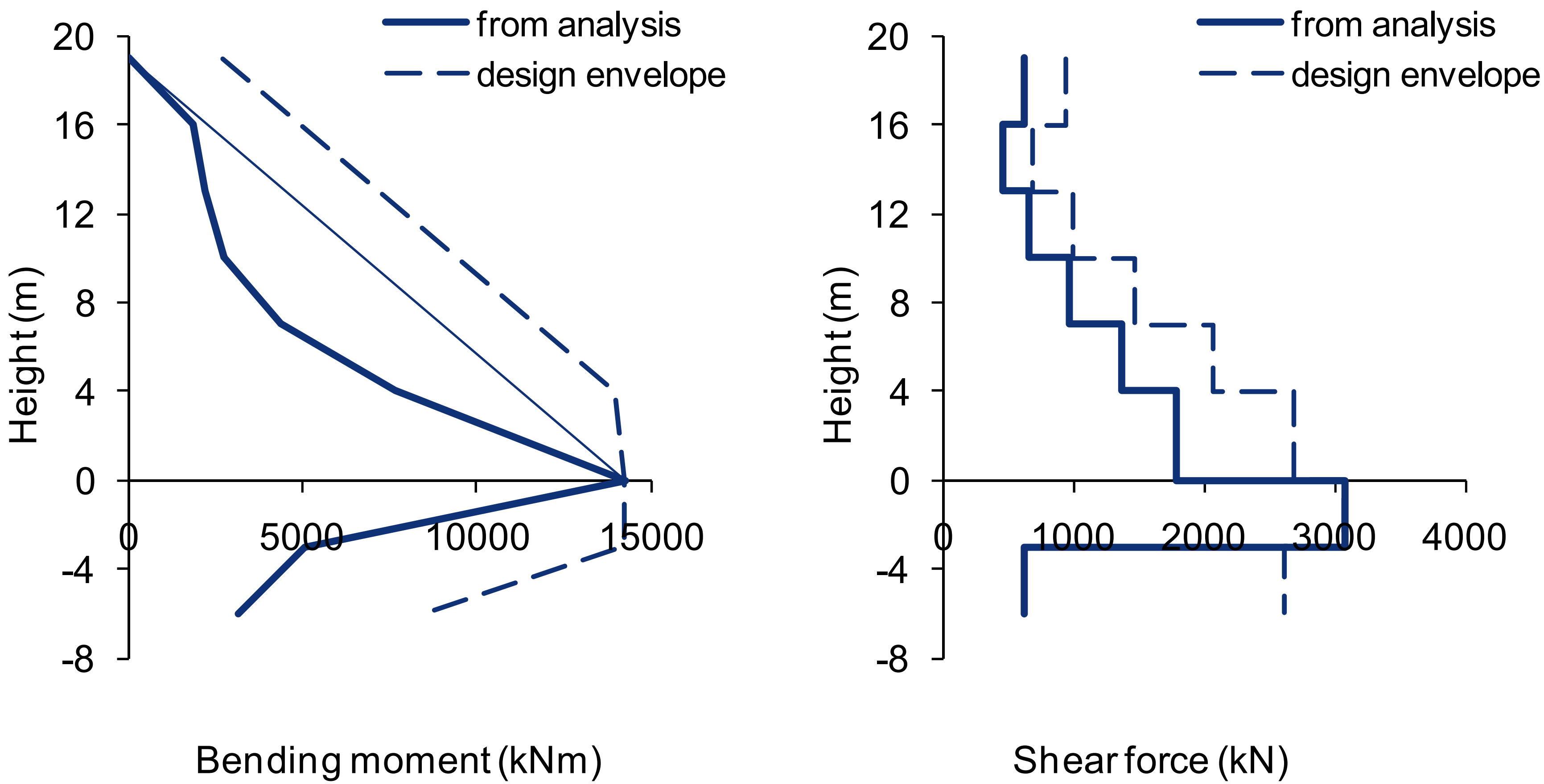
ULS DESIGN OF TWO-WAY REINFORCEMENT AT FOOTING BOTTOM

Maximum bending moments: Vert. section //bz MEdy/bz (kNm/m)	Vert. section //bz Combinat.	Vert. section //by MEdz/by (kNm/m)	Vert. section //by Combinat.	Reinforcement: Bar dia. (mm)	//by spacing (mm)	//by No.	//bz spacing (mm)	//bz No.
0.0	0	13.5	10	12	150	33	150	26

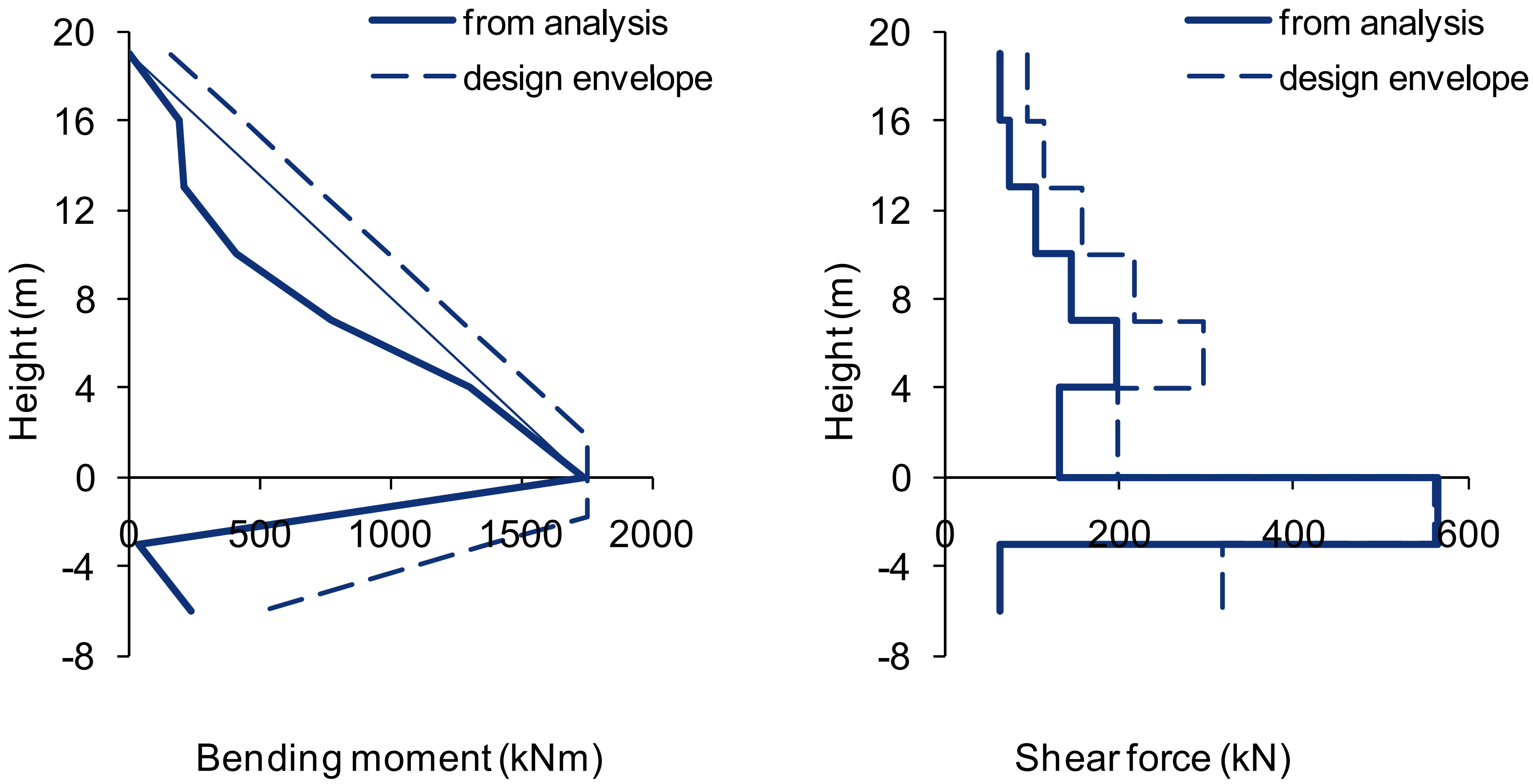
Wall N1


1
2
3
4
5
6
A
B
C
D
6.00
7.00
4.00
3.60
0.25
0.30
1.80
W1
W2
W3
W4
N1
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C14
C15
C16
B1 (0.25X0.50)
B2 (0.25X0.50)
B3 (0.25X0.50)
B4 (0.25X0.50)
B5 (0.25X0.50)
B6 (0.25X0.50)
B7 (0.25X0.50)
B8 (0.25X0.50)
B9 (0.25X0.50)
B10 (0.25X0.50)
B11 (0.25X0.50)
B12 (0.25X0.50)
B13(0.25X0.50)
B14 (0.25X0.50)
SLAB
(t=0.18m)
C1/C6 and C11/C16 = 0.30x0.70m
C7/C10 = 0.50x0.50m
TYPICAL PLAN

Wall N1 – direction X



Wall N1 – direction Y



Wall N1

DESIGN IN SHEAR W/O SHORT-SHEAR-SPAN EFFECTS (Web diagonal compression/tension)

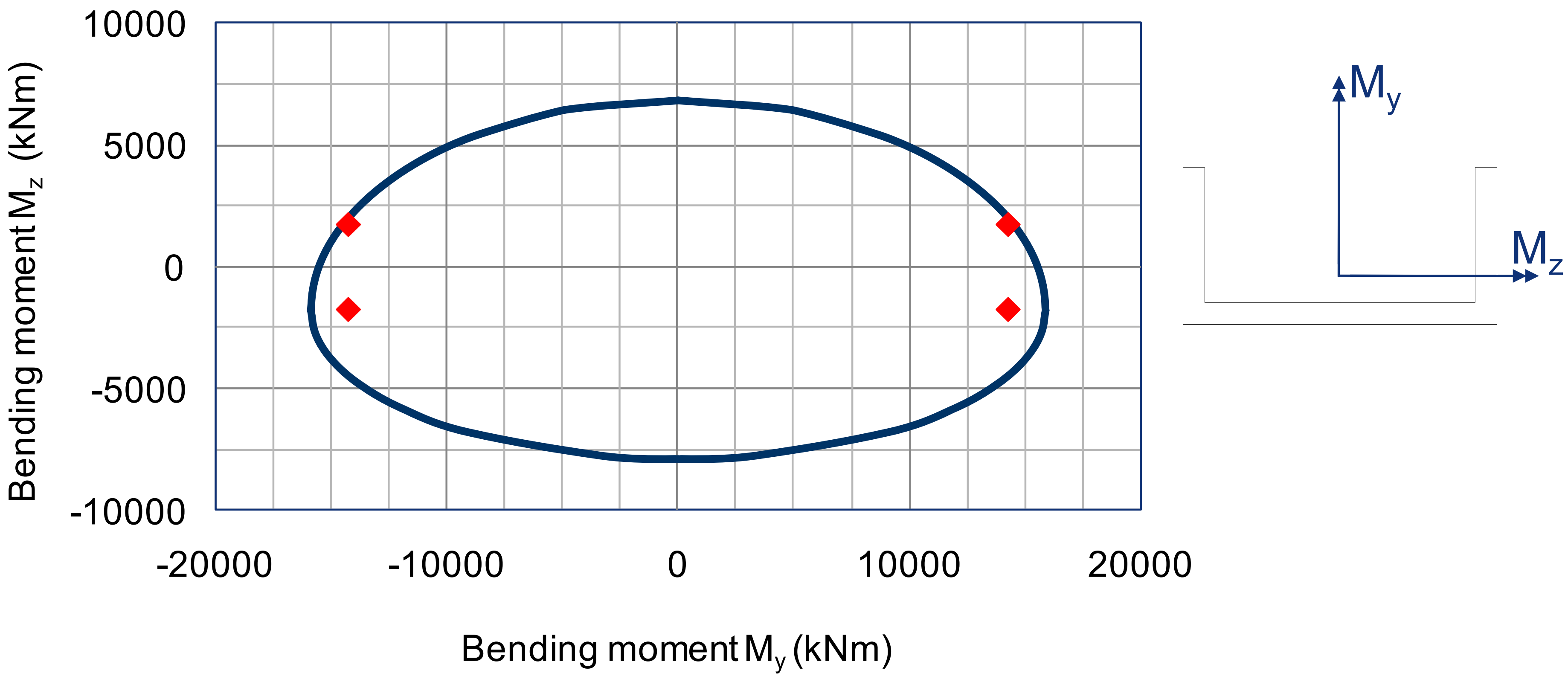
Storey and location		Design shear maxVEd (kN)	Horizontal bars dia. (mm)	legs	spacing-sh maximum (mm)	provided (mm)	strut angle (deg)	Resistance VR,s (kN)	Resistance VR,max (kN)
6	WEB	942.8	8	2	200	200	21	1573.5	2234.5
	FLANGES	96.0	8	2x 2	200	200	21	1573.5	2234.5
5	WEB	687.5	8	2	200	200	21	1573.5	2234.5
	FLANGES	113.6	8	2x 2	200	200	21	1573.5	2234.5
4	WEB	1003.2	8	2	200	200	21	1573.5	2234.5
	FLANGES	157.5	8	2x 2	200	200	21	1573.5	2234.5
3	WEB	1465.4	8	2	200	200	21	1573.5	2234.5
	FLANGES	217.6	8	2x 2	200	200	21	1573.5	2234.5
2	WEB	2070.0	8	2	200	150	21	2098.0	2234.5
	FLANGES	296.1	8	2x 2	200	150	21	1573.5	2234.5
1	WEB	2695.9	10	2	250	135	28	2705.3	2705.3
	FLANGES	197.9	10	2x 2	250	135	21	1966.9	2234.5
0	WEB	3073.4	10	2	250	85	36	3104.9	3104.9
	FLANGES	570.4	10	2x 2	250	85	21	1966.9	2234.5
-1	WEB	2617.5	10	2	250	145	27	2636.3	2636.3
	FLANGES	320.0	10	2x 2	250	145	21	1966.9	2234.5

Wall N1

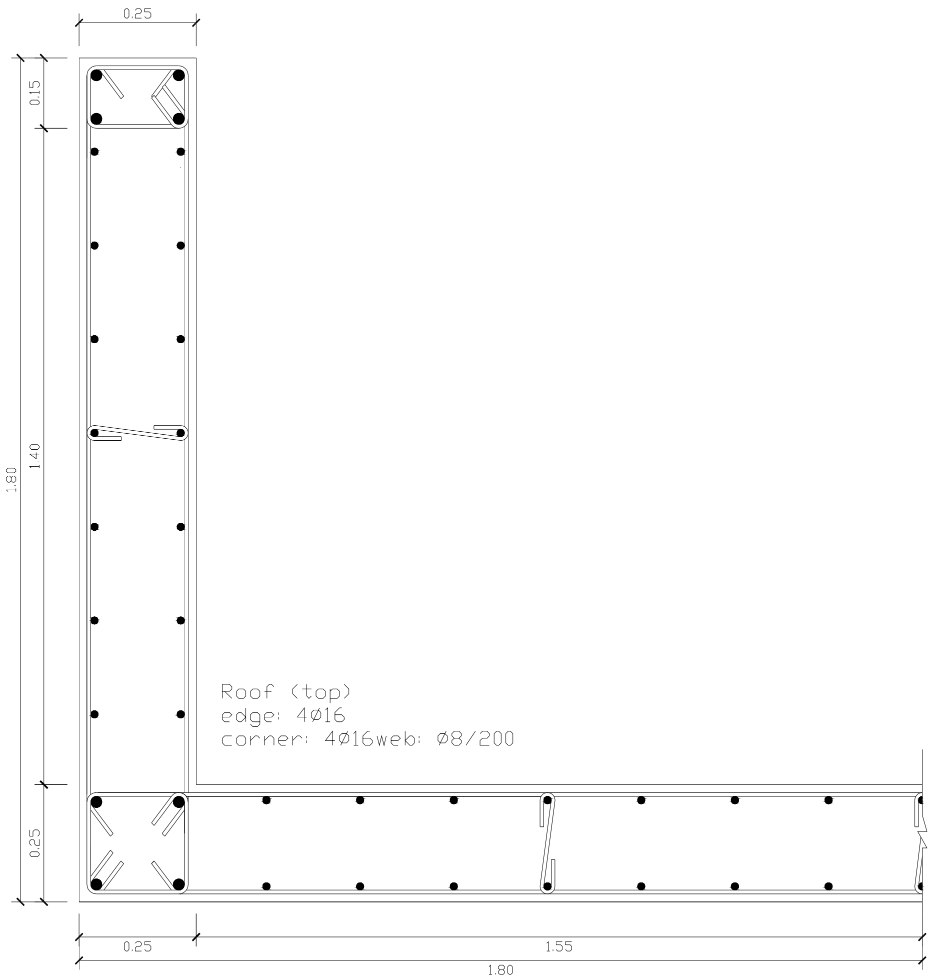
VERTICAL / HORIZONTAL / HOOP REINFORCEMENT (Story and base of above)

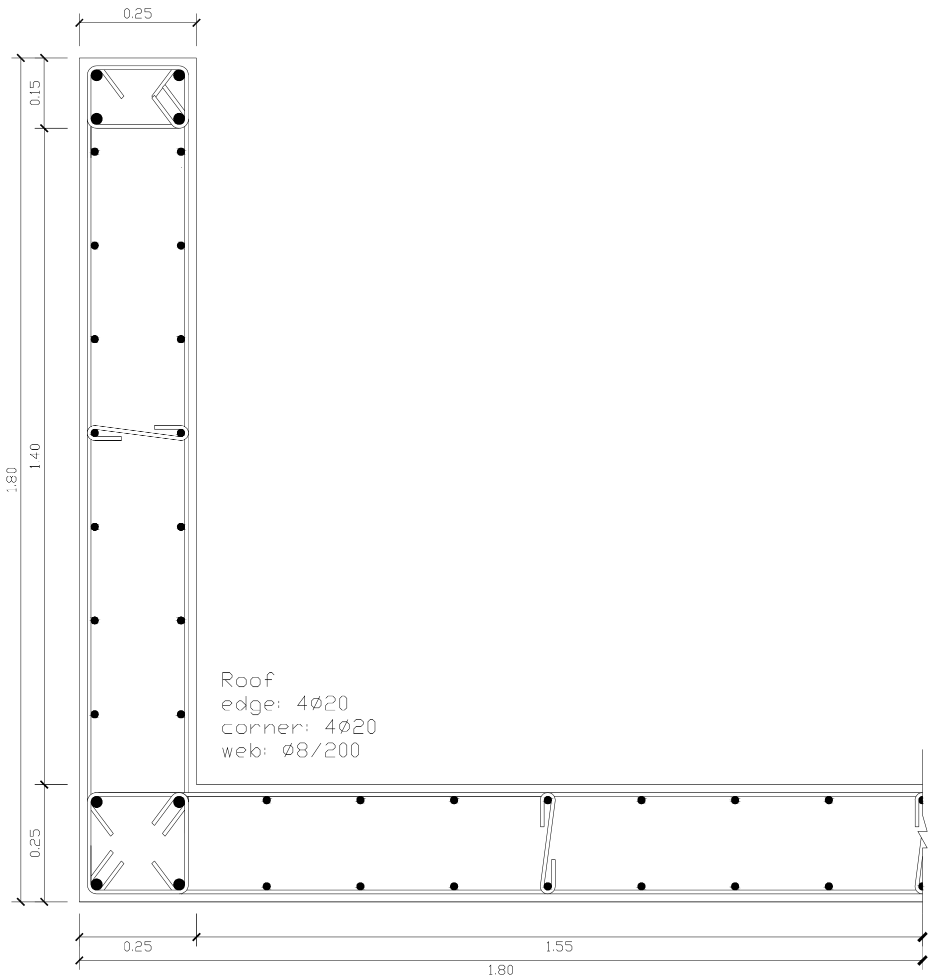
STO	BOUNDARY ELEMENTS: DIMENSIONS & REINFORCEMENT Location	Dimensions (m)	Vert. dia (mm)	Vert. #	Hoops dia (mm)	Hoops s	Hoops Req	Hoops Prov	WEB REINFORCEMENT	Vertic dia (mm)	Vertic sv	Horiz. dia (mm)	Horiz. sh	Addit Joint Reinf (mm2)
6	CORNERS	0.25X.25	16	4	8	110	0.00	0.30	WEB	8	200	8	200	0
	EDGES	0.15X.25	16	4	8	110	0.00	0.43	FLG	8	200	8	200	
5	CORNERS	0.25X.25	20	4	8	110	0.00	0.30	WEB	8	200	8	200	0
	EDGES	0.15X.25	20	4	8	110	0.00	0.43	FLG	8	200	8	200	
4	CORNERS	0.25X.25	20	5	8	110	0.00	0.30	WEB	8	200	8	200	0
	EDGES	0.15X.25	20	5	8	110	0.00	0.26	FLG	8	200	8	200	
3	CORNERS	0.25X.25	20	7	8	110	0.00	0.37	WEB	8	200	8	200	0
	EDGES	0.25X.25	20	7	8	110	0.00	0.26	FLG	8	200	8	200	
2	CORNERS	0.35X.25-0.35X.25	20	12	8	110	0.00	0.22	WEB	8	200	8	150	0
	EDGES	0.35X.25	20	12	8	110	0.00	0.24	FLG	8	200	8	200	
1	CORNERS	0.40X.25-0.55X.25	20	12	8	110	0.00	0.22	WEB	8	200	10	135	0
	EDGES	0.40X.25	20	12	8	110	0.00	0.24	FLG	8	200	10	250	
0	CORNERS	0.40X.25-0.55X.25	20	12	8	110	0.00	0.22	WEB	8	200	10	85	0
	EDGES	0.40X.25	20	12	8	110	0.00	0.24	FLG	8	200	10	250	
-1	CORNERS	0.40X.25-0.55X.25	20	12	8	110	0.00	0.22	WEB	8	200	10	145	0
	EDGES	0.40X.25	20	12	8	110	0.00	0.24	FLG	8	200	10	250	
-2	CORNERS	0.40X.25-0.55X.25	20	12	8	110	0.00	0.22	WEB	8	200	10	145	0
	EDGES	0.40X.25	20	12	8	110	0.00	0.24	FLG	8	200	10	250	

Wall N1

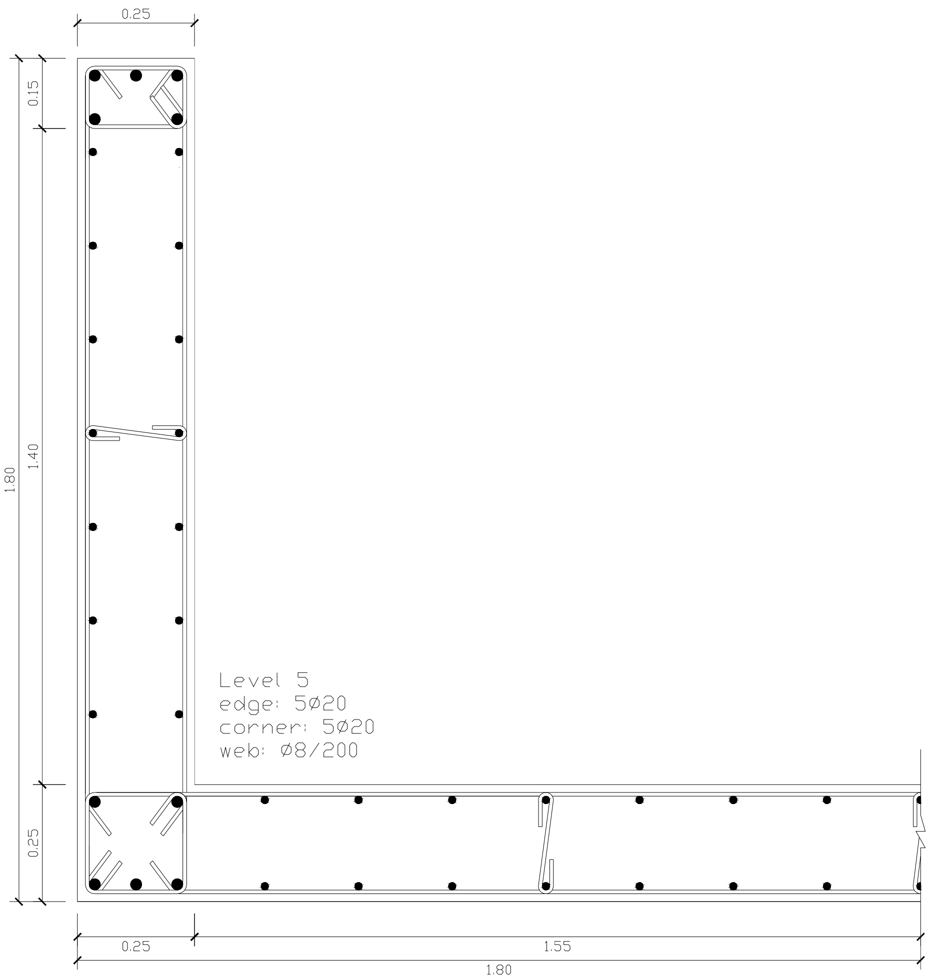

10000
5000
0
-5000
-10000
-20000
-10000
0
10000
20000
Bending moment M_z (kNm)
Bending moment M_y (kNm)
M_y
M_z

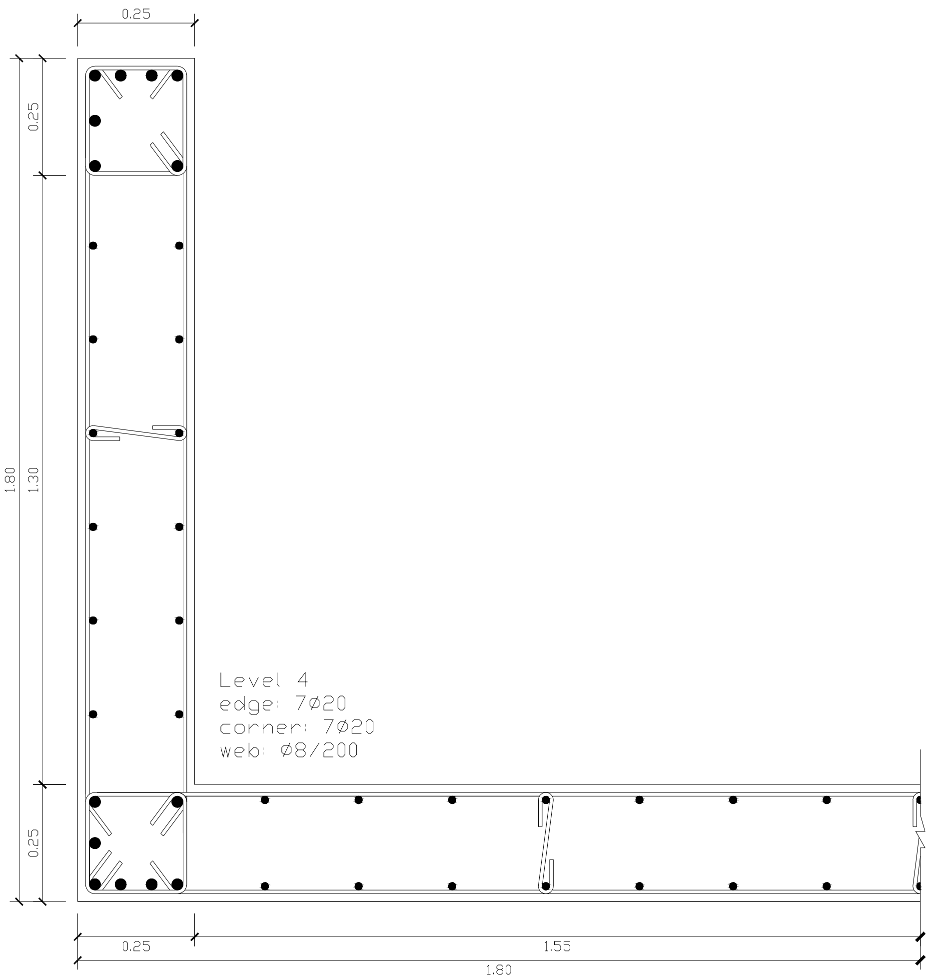
Wall N1


0.25
0.15
1.40
1.80
0.25
Roof (top)
edge: 4Ø16
corner: 4Ø16web: Ø8/200
0.25
1.55
1.80

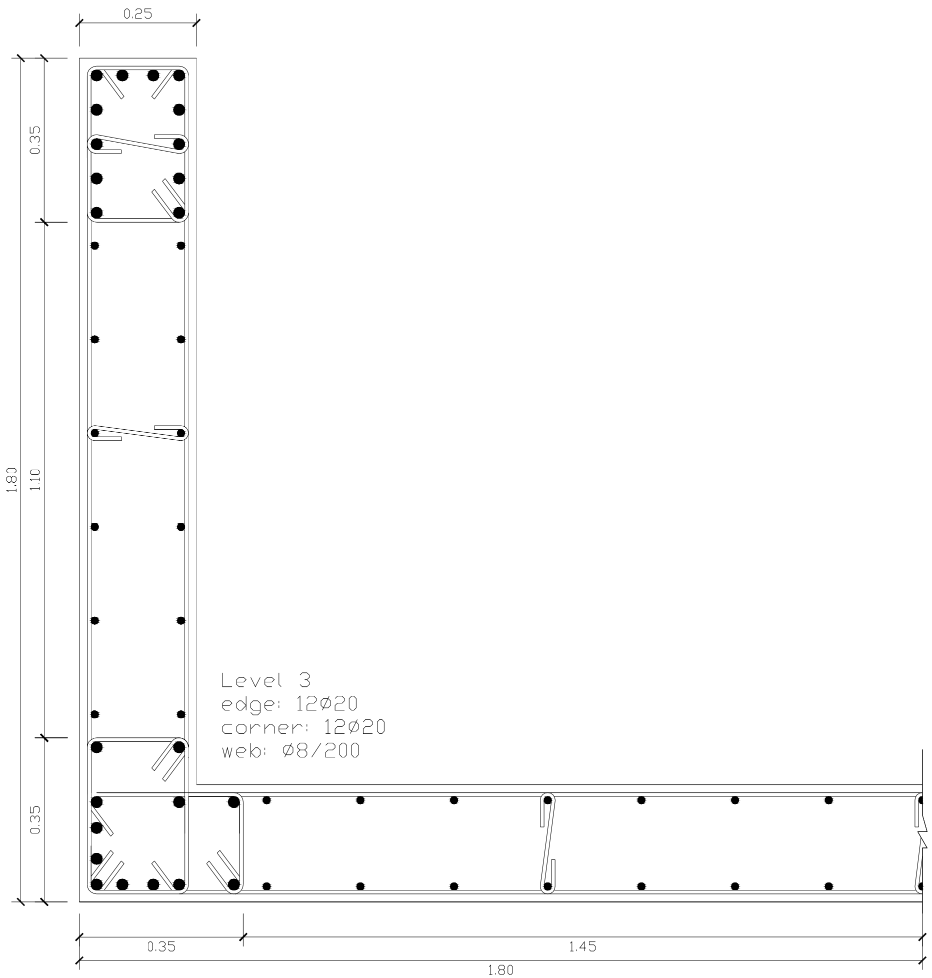

0.25
0.15
1.40
1.80
0.25
Roof
edge: 4Ø20
corner: 4Ø20
web: Ø8/200
0.25
1.55
1.80

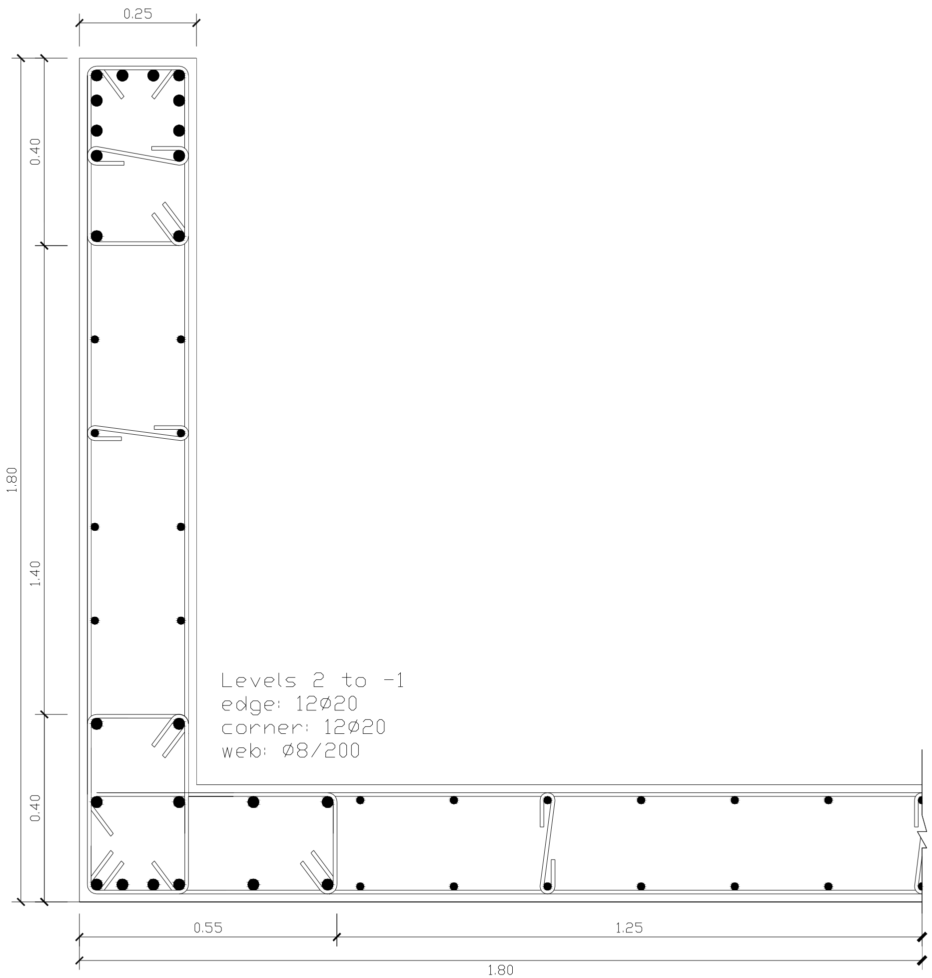
Wall N1


0.25
0.15
1.40
1.80
0.25
Level 5
edge: 5Ø20
corner: 5Ø20
web: Ø8/200
0.25
1.55
1.80


0.25
0.25
1.30
1.80
0.25
Level 4
edge: 7Ø20
corner: 7Ø20
web: Ø8/200
0.25
1.55
1.80

Wall N1


0.25
0.35
1.80
1.10
0.35
Level 3
edge: 12ø20
corner: 12ø20
web: ø8/200
0.35
1.45
1.80


0.25
0.40
1.80
1.40
0.40
Levels 2 to -1
edge: 12ø20
corner: 12ø20
web: ø8/200
0.55
1.25
1.80

Wall N1

FOOTING OF WALL : N1

Undr. shear strength in seismic design sitation: 270kPa in Eqs.6.10a/b: 300kPa

Friction angle & cohesion under drained conditions for Eqs.6.10a/b: 20deg,50kPa

footing depth h(m): 0.80	Footing plan dimension(m): //y by=4.50 //z bz=2.50
found. depth (m): 0.80	Member section outline(m): //y cy=3.60 //z cz=1.80
	Member axis eccentricity(m): //y ay=0.00 //z az=0.00

FOUNDATION DESIGN FORCES AT FOOTING CENTRE - SOIL BEARING PRESSURE & CAPACITY

Combination of Actions	Cap-Des magnif.	N total (kN)	My (kNm)	ey/by	Vy (kN)	Mz (kNm)	ez/bz	Vz (kN)	Soil Bearing press./capacity (kPa)
EN1990 Eq. 6.10a*	-	3700	0	0.000	0	0	0.000	0	329.0/1738.9
EN1990 Eq. 6.10b*	-	3349	0	0.000	0	0	0.000	0	297.8/1738.9
G+ψ2Q+E+X/+Y/maxN	1.114	4936	4104	0.185	694	208	0.017	71	720.3/1649.6
G+ψ2Q+E-X/+Y/maxN	1.114	4936	4104	0.185	694	208	0.017	71	720.3/1649.6
G+ψ2Q+E+X/-Y/maxN	1.114	4936	4104	0.185	694	207	0.017	72	720.3/1649.7
G+ψ2Q+E-X/-Y/maxN	1.114	4936	4104	0.185	694	207	0.017	72	720.3/1649.7
G+ψ2Q+E+X/+Y/minN	1.114	4936	4104	0.185	694	208	0.017	71	720.3/1649.6
G+ψ2Q+E-X/+Y/minN	1.114	4936	4104	0.185	694	208	0.017	71	720.3/1649.6
G+ψ2Q+E+X/-Y/minN	1.114	4936	4104	0.185	694	207	0.017	72	720.3/1649.7
G+ψ2Q+E-X/-Y/minN	1.114	4936	4104	0.185	694	207	0.017	72	720.3/1649.7

*Note: The most unfavourable outcome of the application of 6.10a/6.10b applies.

Wall N1

ULS DESIGN OF FOOTING IN SHEAR & PUNCHING SHEAR

Combination of Actions	Shear stress vEd sect.//y vEdy/bzd (kPa)	Shear stress vEd sect.//z VEdz/byd (kPa)	Shear Resist. vRd,c (kPa)	Punching shear at distance av: max stress maxvEd (kPa)	av: crit. distance (m)	Resistance (2d/av)vRd (kPa)
EN1990 Eq. 6.10a*	0.0	0.0	328.1	0.0	0.4	0.0
EN1990 Eq. 6.10b*	0.0	0.0	328.1	0.0	0.4	0.0
G+ψ2Q+E+X/+Y/maxN	0.0	0.0	328.1	0.0	0.4	0.0
G+ψ2Q+E-X/+Y/maxN	0.0	0.0	328.1	0.0	0.4	0.0
G+ψ2Q+E+X/-Y/maxN	0.0	0.0	328.1	0.0	0.4	0.0
G+ψ2Q+E-X/-Y/maxN	0.0	0.0	328.1	0.0	0.4	0.0
G+ψ2Q+E+X/+Y/minN	0.0	0.0	328.1	0.0	0.4	0.0
G+ψ2Q+E-X/+Y/minN	0.0	0.0	328.1	0.0	0.4	0.0
G+ψ2Q+E+X/-Y/minN	0.0	0.0	328.1	0.0	0.4	0.0
G+ψ2Q+E-X/-Y/minN	0.0	0.0	328.1	0.0	0.4	0.0

*Note: The most unfavourable outcome of the application of 6.10a/6.10b applies.

ULS DESIGN OF TWO-WAY REINFORCEMENT AT FOOTING BOTTOM

Maximum bending moments: Vert. section //bz MEdy/bz (kNm/m)	Combinat.	Vert. section //by MEdz/by (kNm/m)	Combinat.	Reinforcement: Bar dia. (mm)	//by spacing (mm)	//by No.	//bz spacing (mm)	//bz No.
72.4	10	21.8	8	12	150	16	150	30