



STRUCTURAL CALCULATION PACKAGE

Propped Reinforced Concrete Foundation Wall

Design to CSA A23.3:19 with NBC 2020 load treatment

Project	Résidence Tremblay — Basement Addition (EXAMPLE)	Project no.	W-2026-0042
Address	1234 Rue Exemple, Montréal QC	Date	2026-07-06
Client	Entreprise Exemple inc.	Rev	A – Example – not for construction
Prepared with	Equilibrio Wall · engine v0.2.0-draft · KAT suite 49 passed, 1 skipped (PUBLISHED layer pending) (public log: equilibrio.build/validation)	Report ID	EQ-A22E7A60
Engineer of record	_____ (name, licence no.)	Status	EXAMPLE

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Computation aid — not engineering advice. All results require review and acceptance by the engineer of record (§7 lists what was not checked).

Executive summary

ALL CHECKS PASS

Governing check: CHK-06 – Crack control – z method (Gergely-Lutz form) · 89% ·
Controlled by minimum code requirement

Design inputs		Executive summary	
Retained height	2.60 m	Wall section	200 mm × 2.60 m (retained 2.60 m)
Span L	2.60 m	Concrete	f'c = 25 MPa · cover 40 mm
Thickness	200 mm	Soil (declared)	γ = 19 kN/m³ · φ' = 30° (GR-2025-114 §5.2)
Concrete f'c	25 MPa	Governing combination	C2: 1.5H + 1.5L
Steel f_y	400 MPa	Governing moment	M_f = 19.0 kN·m/m @ z = 1.47 m
Backfill γ	19 kN/m³	Governing shear	V_f = 31.1 kN/m (at d_v from base)
Friction φ'	30°	Support reactions	R_top = 20.7 · R_base = 36.8 kN/m
Surcharge q	4.8 kPa	Vertical reinforcement	15M @ 300 (interior face)
Water table	below footing	Horizontal reinforcement	10M @ 250
		Status	CHK-01 Flexural resistance, vertical steel 59%
			CHK-02 One-way shear at d_v from base support 33%
			CHK-03 Minimum vertical reinforcement ≥ min (45%)
			CHK-04 Minimum horizontal reinforcement ≥ min (100%)
			CHK-05 Bar spacing limits ≥ min (60%)
			CHK-06 Crack control 89%
			CHK-08 Footing bearing pressure 36%

Full clause-cited derivations for every value: §5. This page is a reading aid, not a substitute for the checks.

1. Design criteria, materials and references

1.1 Codes and references

Document	Edition	Role
CSA A23.3	2019	Concrete design
NBC	2020, Div. B Part 4	Loads, combinations, earth pressure
Geotechnical reference	GR-2025-114 §5.2	Soil parameters, bearing

Report ID EQ-A22E7A60 is a deterministic hash of the appendix input echo and engine version: identical inputs and engine reproduce this identifier exactly, so any two copies of this package can be verified as the same calculation.

1.2 Materials

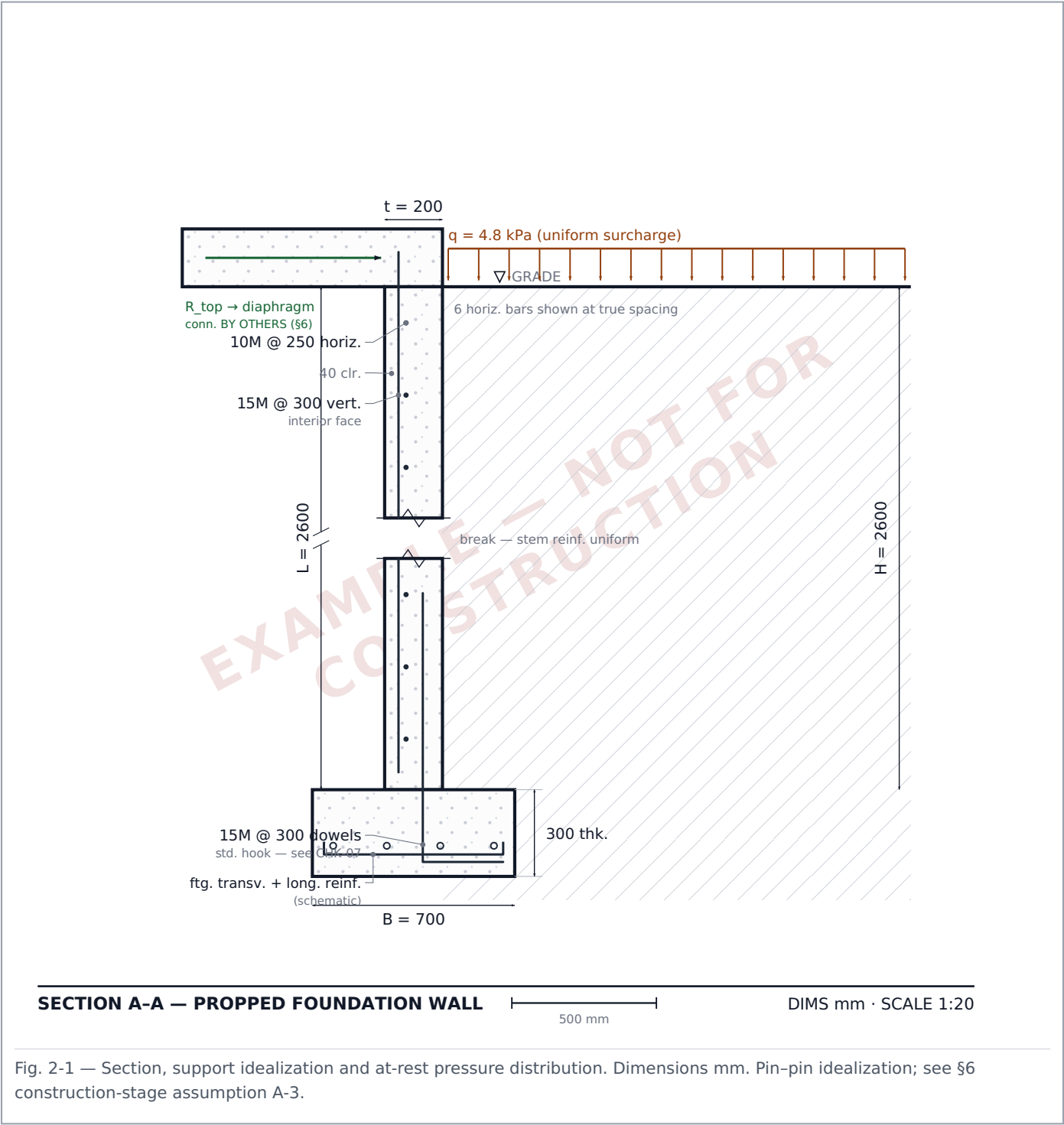
Property	Value	Source / clause
Concrete f'_c (28 d)	25 MPa	specified
Reinforcement f_y	400 MPa	CSA G30.18
γ concrete	24.0 kN/m ³	assumed, normal density
Cover — interior face (tension steel)	40 mm	user-declared

1.3 Soil parameters — declared source

Parameter	Value	Source
Backfill unit weight γ	19.0 kN/m ³	GEOTECH_REPORT · GR-2025-114 §5.2
Effective friction angle ϕ'	30°	GEOTECH_REPORT · GR-2025-114 §5.2
Allowable bearing (SLS)	150 kPa	GEOTECH_REPORT · GR-2025-114 §5.2
Water table	below footing	GEOTECH_REPORT · GR-2025-114 §5.2

Equilibrio Wall does not assume soil parameters. Values above were entered by the user with the declared source shown; the engineer of record is responsible for their applicability.

2. Geometry, support conditions and lateral pressures



2.1 Support idealization

The wall is modelled as a vertical one-way simply supported member spanning $L = 2.600$ m between the basement slab / floor diaphragm (top) and the footing (bottom). Rotational restraint at the footing is conservatively neglected for flexure. The top support is assumed effective; this is only valid once the diaphragm exists and is connected — see assumption A-3.

2.2 Lateral earth pressure

$K_0 = 1 - \sin \phi' = 1 - \sin 30^\circ = 0.500$ [at-rest; propped wall convention – A-1]

$p_0(z) = K_0 \cdot \gamma \cdot z$; p at base = 27.1 kPa (service) [γ , ϕ' per GR-2025-114 §5.2]

Surcharge $q = 4.8$ kPa (uniform) $\rightarrow p_q = K_0 \cdot q = 2.4$ kPa [user-declared; treated as L]

2.3 Pressure and internal-force stations (governing combination)

z (m)	p service (kPa)	p factored (kPa)	V_f (kN/m)	M_f (kN·m/m)
0.00	2.4	3.6	20.7	0.0
0.33	5.5	8.2	18.8	6.5
0.65	8.6	12.9	15.4	12.1
0.98	11.7	17.5	10.5	16.3
1.30	14.8	22.1	4.0	18.7
1.62	17.8	26.8	-3.9	18.8
1.95	20.9	31.4	-13.4	16.0
2.27	24.0	36.0	-24.3	9.9
2.60	27.1	40.6	-36.8	0.0

Stations at L/8; the engine reports any station on request in the saved project.

3. Load combinations and analysis

Combination	factor on H (earth)	factor on L (surcharge)	Clause	Governs
C1: 1.5H	1.50	0.00	NBC 2020 Cl. 4.1.3.2	
C2: 1.5H + 1.5L	1.50	1.50	NBC 2020 Cl. 4.1.3.2	✓

Governing combination: C2: 1.5H + 1.5L

$R_{top} = 20.7$ kN/m ; $R_{base} = 36.8$ kN/m

$M_{f,max} = 19.0$ kN·m/m at $z \approx 1.47$ m below top

V_f at d_v from base support = 31.1 kN/m

Envelope computed numerically from the pressure profiles; the shear demand is enveloped across all combinations. Prop reaction R_{top} must be resisted by the slab/diaphragm and its connection — not checked here (§6).

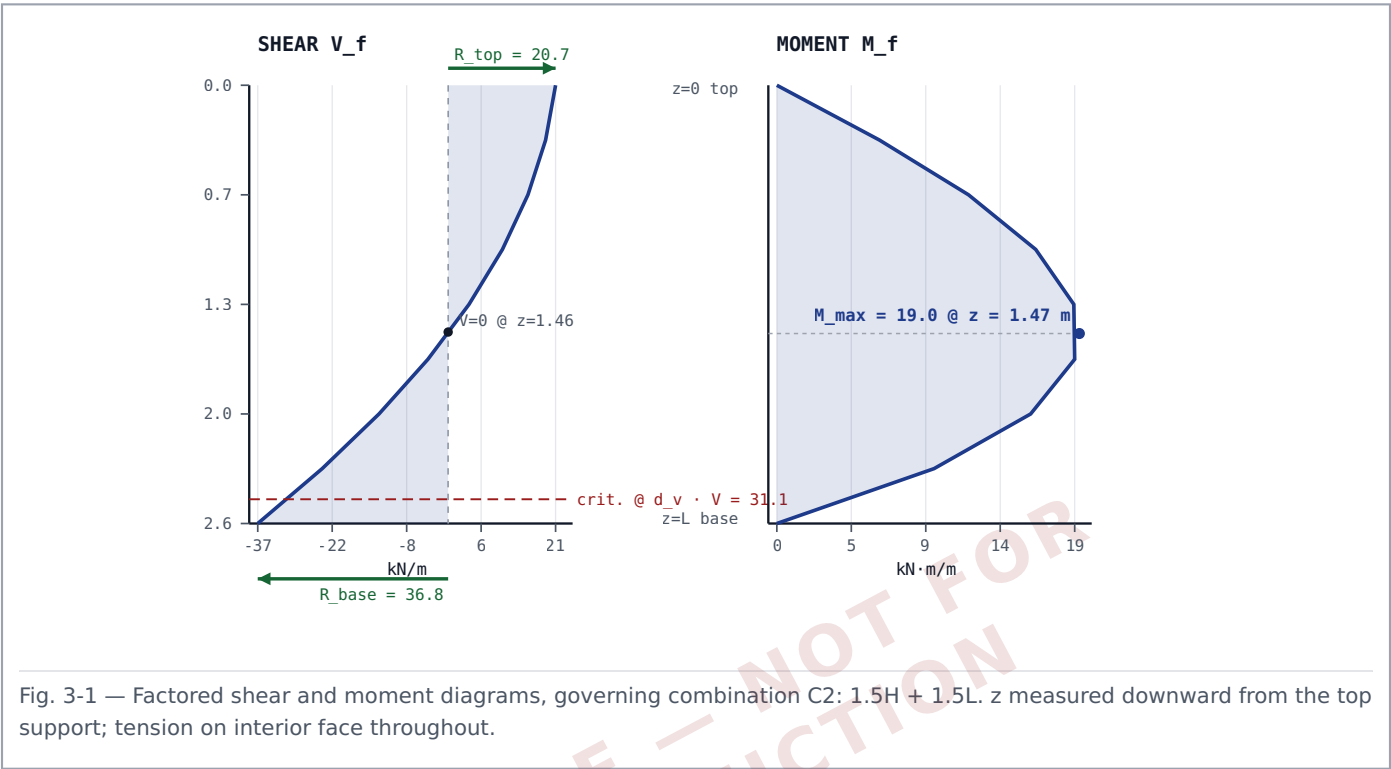


Fig. 3-1 — Factored shear and moment diagrams, governing combination C2: 1.5H + 1.5L. z measured downward from the top support; tension on interior face throughout.

3.1 Method statement

One-way vertical strip of unit width; linear-elastic beam theory; superposition of load cases; envelope taken as the maximum factored effect over the span per combination. Self-weight acts axially and is neglected in flexure (conservative for this geometry).

3.2 Stability treatment

Overturning and sliding checks in the cantilever-wall sense do not apply to this system in service: the wall spans between the floor diaphragm and the footing, and lateral thrust is resisted by the structural load path. Consequently, stability of this wall is a construction-stage question — the unpropped condition during backfilling is explicitly excluded from this package (assumption A-3) and must be addressed on the drawings by sequencing or temporary bracing.

4. Design checks (clause-cited trace)

CHK-01 — Flexural resistance, vertical steel (interior face)		CSA A23.3-19 Cl. 10.1
DEMAND 19.047 kN·m/m	RESISTANCE 32.508 kN·m/m	UTILIZATION 59%
32.508 kN·m/m ≥ 19.047 kN·m/m → PASS · utilization 0.59		
CALCULATION DETAIL		
A_s = 200·1000/300 = 667 mm²/m		
d = t - cover - d_b/2 = 152 mm		
alpha1 = 0.85 - 0.0015 f'c = 0.812 - [CSA A23.3-19 Cl. 10.1.7]		
a = phi_s·A_s·f_y/(alpha1·phi_c·f'c·b) = 17.2 mm		
M_r = phi_s·A_s·f_y·(d - a/2) = 32.5 kN·m/m [CSA A23.3-19 Cl. 10.1.3]		
c/d = a/(beta1·d) = 0.124 - [CSA A23.3-19 Cl. 10.5.2]		

CHK-02 — One-way shear at d_v from base support

CSA A23.3-19 Cl. 11.3

DEMAND 31.084 kN/m	RESISTANCE 94.091 kN/m	UTILIZATION  33%
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94.091 kN/m $\geq$ 31.084 kN/m → PASS · utilization 0.33

No shear reinforcement assumed; if FAIL, thicken or engage stirrup design (out of v1 scope).

CALCULATION DETAIL

$$d_v = \max(0.9d, 0.72h) = 144 \text{ mm} \quad [\text{CSA A23.3-19 Cl. 11.3.9}]$$

$$\beta = 230/(1000+d_v) = 0.201 \quad [\text{CSA A23.3-19 Cl. 11.3.6.3(b)}]$$

$$V_c = \phi_c \cdot \lambda \cdot \beta \cdot \sqrt{f'_c} \cdot b \cdot d_v = 94.1 \text{ kN/m} \quad [\text{CSA A23.3-19 Cl. 11.3.4}]$$

CHK-03 — Minimum vertical reinforcement

CSA A23.3-19 Cl. 14.1.8.5

DEMAND 300.000 mm²/m	RESISTANCE 666.667 mm²/m	UTILIZATION $\geq \text{min (45\%)}$
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666.667 mm²/m $\geq$ 300.000 mm²/m → PASS · utilization 0.45

Code-minimum floor, not a demand/capacity ratio.

CALCULATION DETAIL

$$A_{s,\text{min}} = 0.0015 \cdot A_g = 0.0015 \cdot t \cdot 1000 = 300 \text{ mm}^2/\text{m} \quad [\text{CSA A23.3-19 Cl. 14.1.8.5}]$$

$$A_{s,\text{prov}} = 667 \text{ mm}^2/\text{m}$$

CHK-04 — Minimum horizontal reinforcement

CSA A23.3-19 Cl. 14.1.8.6

DEMAND 400.000 mm²/m	RESISTANCE 400.000 mm²/m	UTILIZATION $\geq \text{min (100\%)}$
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400.000 mm²/m $\geq$ 400.000 mm²/m → PASS · utilization 1.00

Code-minimum floor, not a demand/capacity ratio.

CALCULATION DETAIL

$$A_{s,\text{min}} = 0.0020 \cdot A_g = 0.0020 \cdot t \cdot 1000 = 400 \text{ mm}^2/\text{m} \quad [\text{CSA A23.3-19 Cl. 14.1.8.6}]$$

$$A_{s,\text{prov}} = 400 \text{ mm}^2/\text{m}$$

CHK-05 — Bar spacing limits

CSA A23.3-19 Cl. 14.1.8.4

DEMAND 300.000 mm	RESISTANCE 500.000 mm	UTILIZATION $\geq \text{min (60\%)}$
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500.000 mm $\geq$ 300.000 mm → PASS · utilization 0.60

Detailing limit, not a demand/capacity ratio.

CALCULATION DETAIL

$$s_{\text{prov,max}} = \max(s_{\text{vert}}=300, s_{\text{horiz}}=250) = 300 \text{ mm}$$

$$s_{\text{max}} = \min(3t, 500) = 500 \text{ mm} \quad [\text{CSA A23.3-19 Cl. 14.1.8.4}]$$

CHK-06 — Crack control — z method (Gergely-Lutz form)

CSA A23.3-19 Cl. 10.6.1

DEMAND 26.736 kN/mm	RESISTANCE 30.000 kN/mm	UTILIZATION  89%
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30.000 kN/mm $\geq$ 26.736 kN/mm → PASS · utilization 0.89Methodology: A23.3 z-parameter check with f_s taken as $0.6f_y$ in lieu of cracked-section analysis; interior exposure limit.

CALCULATION DETAIL

$$d_c = \text{cover} + d_b/2 = 48 \text{ mm}$$

$$A = 2 \cdot d_c \cdot s \text{ (concrete tension area per bar)} = 2.88e+04 \text{ mm}^2$$

$$f_s = 0.6 \cdot f_y \text{ (permitted approximation in lieu of analysis)} = 240 \text{ MPa} \quad [\text{CSA A23.3-19 Cl. 10.6.1}]$$

$$z = f_s \cdot (d_c \cdot A)^{(1/3)} = 26.7 \text{ kN/mm} \quad [\text{CSA A23.3-19 Cl. 10.6.1}]$$

$$z_{\text{lim}} = \text{interior exposure} = 30 \text{ kN/mm}$$

CHK-07 — Required development of vertical bars into footing (dowels)

CSA A23.3-19 Cl. 12.2

460.80000000000007 mm — reported for EOR review (informational — not a pass/fail gate)

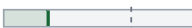
Engine reports the REQUIRED length only; anchorage is a detailing decision the EOR confirms on the drawings.

CALCULATION DETAIL

$$l_d = 0.45 \cdot k_1 \cdot k_2 \cdot k_3 \cdot k_4 \cdot (f_y / \sqrt{f'_c}) \cdot d_b = 461 \text{ mm} \quad [\text{CSA A23.3-19 Cl. 12.2.3}]$$

CHK-08 — Footing bearing pressure (SLS)

geotech report

DEMAND 53.600 kPa	RESISTANCE 150.000 kPa	UTILIZATION  36%
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150.000 kPa $\geq$ 53.600 kPa → PASS · utilization 0.36

CALCULATION DETAIL

$$q_{\text{serv}} = N_{\text{serv}} / B = 53.6 \text{ kPa}$$

$$q_{\text{all}} = 150 \text{ kPa} \quad [\text{declared soil source}]$$

5. Summary of results and specified reinforcement

Check	Clause	Demand	Resistance	utilization	Result	See p.
Flexural resistance, vertical steel (interior face)	CSA A23.3-19 Cl. 10.1	19.047 kN·m/m	32.508 kN·m/m	59%	PASS	6
One-way shear at d_v from base support	CSA A23.3-19 Cl. 11.3	31.084 kN/m	94.091 kN/m	33%	PASS	7
Minimum vertical reinforcement	CSA A23.3-19 Cl. 14.1.8.5	300.000 mm ² /m	666.667 mm ² /m	≥ min	PASS	7
Minimum horizontal reinforcement	CSA A23.3-19 Cl. 14.1.8.6	400.000 mm ² /m	400.000 mm ² /m	≥ min	PASS	7
Bar spacing limits	CSA A23.3-19 Cl. 14.1.8.4	300.000 mm	500.000 mm	≥ min	PASS	7
Crack control — z method (Gergely-Lutz form)	CSA A23.3-19 Cl. 10.6.1	26.736 kN/mm	30.000 kN/mm	89%	PASS	8
Required development of vertical bars into footing (dowels)	CSA A23.3-19 Cl. 12.2	460.800 mm	—	—	INFO	8
Footing bearing pressure (SLS)	geotech report	53.600 kPa	150.000 kPa	36%	PASS	8

5.1 Specified reinforcement

Location	Bars	Notes
Vertical, interior face	15M @ 300	Full height; lap to footing dowels
Horizontal	10M @ 250	Full height, single layer at interior face
Footing dowels	15M @ 300	Anchorage per CHK-07; detail by EOR

6. Declared limitations, assumptions and revision history

6.1 Not checked by this tool — responsibility of the engineer of record

Item
Global (slope) stability
Uplift / flotation of the structure under the declared water table
Whether the declared water level is the correct design level (seasonal high, flood, or perched water)
Drainage system performance — the declared water table is taken as given
Seismic site response / seismic earth pressure
Settlement and serviceability of adjacent structures
Construction-stage backfilling before the top prop exists
Slab/diaphragm capacity and connection for the top reaction
Frost action beyond declared frost depth; exposure/durability class selection

6.2 Assumptions register

ID	Assumption	Source / action
A-1	At-rest (K_0) pressure used: wall restrained top and bottom, no rotation to mobilize the active state.	Convention for propped basement walls
A-2	Backfill drained; water table below footing. No hydrostatic pressure is applied — the drainage system is assumed to perform.	GR-2025-114 §5.2 — EOR verify drainage detail
A-3	Backfilling occurs only after the floor diaphragm is in place and connected, or the wall is braced.	EOR to specify on drawings
A-4	Surcharge limited to declared $q = 4.8$ kPa; no heavier loads adjacent during service or construction.	User-declared — EOR verify
A-5	Normal-density concrete; interior exposure for crack control.	User-declared

6.3 Revision history

Rev	Date	Description	Engine
A	2026-07-06	Example — not for construction	v0.2.0-draft · KAT suite 49 passed, 1 skipped (PUBLISHED layer pending)

6.4 Engineer-of-record review checklist

- ☐ Soil parameters (§1.3) match the referenced geotechnical source, and that source applies to this site and this wall.
- ☐ Support idealization (§2.1) matches the actual structure; the top prop and its connection can deliver R_{top} shown in §3.
- ☐ Backfilling sequence or temporary bracing (A-3) is specified on the drawings.
- ☐ Drainage detail satisfies assumption A-2; hydrostatic pressure cannot develop.

- ☐ Surcharge declaration reflects real construction and service conditions.
- ☐ Exposure class, cover and durability requirements confirmed for this environment.
- ☐ Seismic, frost, settlement and global stability addressed elsewhere in the project as required (§6.1).
- ☐ Reinforcement schedule (§5.1) transferred to drawings; dowel detail produced.
- ☐ Input echo (§7) spot-checked against project documents; Report ID recorded in project file.

6.5 Review and acceptance

Prepared by M. Example Date	Engineer of record Signature name, licence no. Date	Seal The undersigned has reviewed and verified the inputs, methods, applicability and results of this calculation and accepts responsibility for the design. Software output is not a sealed document; sealing is the act of the engineer.
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7. Appendix — input echo and validation statement

7.1 Exact input echo (reproducibility)

```
{
  "code_context": "NBC2020_P4",
  "concrete": {
    "cover_int_mm": 40.0,
    "fc_MPa": 25.0,
    "gamma_kNm3": 24.0
  },
  "geometry": {
    "footing_b_mm": 700.0,
    "footing_t_mm": 300.0,
    "retained_height_m": 2.6,
    "span_m": 2.6,
    "thickness_mm": 200.0
  },
  "n_service_top_kN_m": 20.0,
  "soil": {
    "allowable_bearing_kPa": 150.0,
    "gamma_kNm3": 19.0,
    "gamma_sat_kNm3": null,
    "phi_deg": 30.0,
    "source": "GEOTECH_REPORT",
    "source_ref": "GR-2025-114 \u00a775.2",
    "water_depth_m": null,
    "water_table": "BELOW_FOOTING"
  },
  "steel": {
    "fy_MPa": 400.0,
    "horiz_bar": "10M",
    "horiz_spacing_mm": 250.0,
    "vert_bar": "15M",
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```
"vert_spacing_mm": 300.0
},
"surcharge": {
  "q_kPa": 4.8,
  "strip_start_m": null,
  "strip_width_m": null,
  "type": "UNIFORM"
}
}
```

7.2 Validation statement

This report was produced by Equilibrio Wall engine v0.2.0-draft. Prior to release, this engine version's Known-Answer Test suite reported: KAT suite 49 passed, 1 skipped (PUBLISHED layer pending). The public log of references, inputs, results and tolerances is at equilibrio.build/validation. A failing test mechanically blocks release. Validation of the software does not replace review of this specific calculation by the engineer of record.

7.3 Units and conventions

SI throughout: kN, kPa, MPa, mm, m as shown. Per-metre-of-wall basis. z measured downward from top of wall. Intermediate values shown rounded; computations carried at full precision.

EXAMPLE — NOT FOR
CONSTRUCTION