



WIRE ROPE SUSPENSION CALCULATION — ASME

ASME A17.6-2022 · A17.1-2022/CSA B44:22 §2.20.3 · generated by RopeFactor v0.4.169

DRAFT — not for construction

PROJECT INFORMATION

PROJECT	DOCUMENT NO.	JOB / CALC NO.
—	—	—
CALC DATE	CUSTOMER	SPEC SECTION
—	—	—
ENGINEER	REVIEWER	COMPANY
—	—	—
BUILDING	REVISION	ROPEFACTOR VERSION
—	—	v0.4.169

PART A · ROPE SELECTION

A17.6 App. I

Rope (custom)	Custom (certificate)	Manufacturer certificate
Construction · core	8x19 Warrington / IWRC	A17.6 App. I
Diameter	0.500 in	12.7 mm cross-ref
Steel grade R0 (nominal)	1770	manufacturer certificate (nominal steel grade)
MBF (S) per rope	26.60 kips	118.32 kN · 26,600 lbf

PART A · INSTALLATION PARAMETERS

Car mass P	8,000 lb	job input
Rated load Q	4,000 lb	job input
Counterweight	10,000 lb	job input
Number of ropes N	6	job input
Travel H	200' -0"	60.96 m · job input
Roping ratio	1:1	from reeving
Rated speed	350 fpm	1.78 m/s
Sheave diameter Dt	24.0 in	
Deflector pulleys (Nps / Npr)	0 / 0	0 = traction sheave only
Overhead (top landing -> drive-sheave centre)	8' -0"	2.44 m · drives B5

Building · floors NF · trips/day	Office · 18 · 200	operating profile
Service type	Passenger	A17.1 service class

REEVING SCHEMATIC – AS COMPUTED, NOT TO SCALE			Roping Studio · read-only
T The diagram illustrates a pulley system. At the top is a pulley labeled 'T'. A rope passes over it, with one end attached to a 'CAR' and the other end attached to a counterweight. The counterweight is represented by a vertical rectangle with horizontal lines. Below the pulley, there is a label 'x6' with three diagonal lines, indicating six ropes. A large 'DRAFT' watermark is visible across the diagram.			
DT	D	DT / D	α WRAP
24.0 in	0.500 in	48.0	180°
ROPING	N_S	NPS/NPR	GROOVE
1:1	6	0/0	U-undercut

PART A • FACTOR OF SAFETY		A17.1 §2.20.3
Min Sf (Table 2.20.3)	9.50	exact table-speed row
<i>(exact A17.1 Table 2.20.3 speed match)</i>		
Breaking strength S	26.60 kips	118.32 kN per rope
Runs of suspension N	6	6 ropes × 1 roping
Max static load W	12.56 kips	55.85 kN
$W = \max(\text{bottom}, \text{top})$. Bottom = $(P+Q) + \text{rope weight} = 12.004 + 0.553 = 12.557 \text{ kips}$ · Top = $(P+Q) = 12.004 \text{ kips} \rightarrow W = 12.557 \text{ kips}$		
Actual Sf (computed)	12.71	$f = (S \times N) / W$
$f = (S \cdot N) / W = 118.32 \times 6 / 55.85 = \mathbf{12.71}$		
%MBF full = $T_{full} / MBF = 9.31 / 118.32 = 7.87\%$ · empty = $6.14 / 118.32 = 5.19\%$		
Sheave geometry Dt / d	48.0	A17.1 §2.24.2.2 – required ≥ 40
✓ PASS – COMBINED		$f \ 12.71 \geq \min \ 9.50 \cdot D/d \checkmark$

U-1 conformance

Traction-loss detection (§2.20.8.1) Conforms – Table U-1 ($d \geq 9.5 \text{ mm SWR}$): traction-loss detection installed

SAFETY FACTOR – actual vs required

Sf actual		✓ MEETS 12.71
MUST MEET		
$reqd \geq 9.50$		
$Bar = Sf \text{ actual} \cdot line = \text{required minimum, arrowhead to the safe (reach/exceed) side.}$		

PART A • ROPE LOADING

% MBF – empty car	5.19 %	✓ $\geq 2.5\%$ – IWRC seating floor met
% MBF – full load	7.87 %	Worst-case rope loading

PART A • METHODOLOGY & STANDARDS CITED

- Rope selection & MBF: ASME A17.6-2022 Mandatory Appendix I (Tables I-1-1 ... I-1-9).
- Min factor of safety: A17.1-2022/CSA B44:22 §2.20.3 + Table 2.20.3 (exact table-speed row – no interpolation).
- Actual factor of safety: A17.1-2022 §2.20.3 – $f = (S \times N) / W$.
- Sheave pitch diameter: A17.1-2022 §2.24.2.2 (suspension $Dt \geq 40 \cdot d$).
- Conformance: A17.1-2022 Nonmandatory Appendix U Table U-1.

B1 • TRACTION CAPACITY

ISO 8100-2 §4.11 / §4.13.6

Loading and emergency braking are evaluated against the minimum required traction ratio (available $\geq$ demand). The stalled / unit-on-buffer condition is evaluated against the maximum permissible ratio for rope slip (available $\leq$ demand).

ASME A17.1 does not prescribe a closed-form traction calculation. ISO 8100-2 methodology is included as an engineering verification.

Wrap angle α	180 °	3.1416 rad
Rope speed v	1.78 m/s	Car speed $\times$ roping
Friction f – loading	0.1849	$\mu = 0.100 \cdot \text{§4.13.6.1.2}$
$f = \mu \cdot 4 \cdot (\cos(\gamma/2) - \sin(\beta/2)) / (\pi - \beta - \gamma - \sin \beta + \sin \gamma) = 0.100 \cdot 4 \cdot (\cos 17.5^\circ - \sin 45.0^\circ) / (\pi - 1.571 - 0.611 - \sin 90^\circ + \sin 35^\circ) = 0.1849 \cdot \text{Formula 24}$		
Friction f – emergency braking	0.1570	$\mu = 0.085$
$\mu_{\text{brake}} = \mu / (1 + v/10) = 0.100 / (1 + 1.78/10) = 0.0849 \rightarrow f_{\text{brake}} = f_{\text{load}} \cdot (\mu_{\text{brake}} / \mu) = 0.1849 \cdot (0.0849 / 0.100) = 0.1570$		
Friction f – stalled / on-buffer	0.3698	$\mu = 0.200$
$f_{\text{stall}} = \text{Formula (24) at } \mu_{\text{stall}} = f_{\text{load}} \cdot (\mu_{\text{stall}} / \mu) = 0.1849 \cdot (0.200 / 0.100) = 0.3698$		
Loading – available $e^{(f \cdot \alpha)}$	1.788	✓ $\checkmark$ PASS $\cdot$ demand 1.355
$\text{available} = e^{(f \cdot \alpha)} = e^{(0.1849 \times 3.1416)} = 1.788$		
Stalled – available $e^{(f \cdot \alpha)}$	3.196	✓ $\checkmark$ PASS $\cdot$ demand 14.483
$\text{available} = e^{(f \cdot \alpha)} = e^{(0.3698 \times 3.1416)} = 3.196$		
Emergency braking – available $e^{(f \cdot \alpha)}$	1.638	✓ $\checkmark$ PASS – guide-rail friction taken as zero (§4.11.3). $\cdot$ demand 1.461
$\text{available} = e^{(f \cdot \alpha)} = e^{(0.1570 \times 3.1416)} = 1.638$		
§4.11.3 demand inputs (SI – kg, gn m/s ² ; force-ratio is dimensionless): P 3,629 $\cdot$ Q 1,814 $\cdot$ G 4,536 $\cdot$ m_{trav} 0.0 $\cdot$ m_{cr} 0.0 $\cdot$ m_{sr} 250.5 $\cdot$ t_d 0.0 $\cdot$ roping r 1 $\cdot$ gn 9.807 $\cdot$ retardation a 0.500		
Loading $T1/T2 = ((P + 1.25Q + m_{\text{trav}})/r + t_d + m_{\text{sr}}) / ((G + m_{\text{cr}})/r + t_d) = ((3,629 + 1.25 \times 1,814 + 0)/1 + 0 + 251) / ((4,536 + 0)/1 + 0) = 1.355$ (car-bottom); $T1/T2 = \max(\text{bottom}, \text{top } 1.232) = 1.355$		
Stalled $T1/T2$ (slip) = $\min(\text{car-bottom } 18.104, \text{cwt-bottom } 14.483) = 14.483$		
Emergency braking $T1/T2 = \max(\text{loaded-low } 1.390, \text{empty-high } 1.461) = 1.461$ – Annex C dynamic form, $m_{\text{sr}} \cdot (gn + r \cdot a)$ with $g \geq a$; guide-rail friction = 0 (none ensured, §4.11.3)		
Dynamic emergency braking (ISO 8100-2 §4.11.2.2 / Annex C C.3–C.6): retardation $a = \max(\text{input}, 0.5 \text{ m/s}^2 \text{ floor})$. Guide-rail (well) friction is taken as zero unless a measured or manufacturer-guaranteed minimum is entered in accordance with ISO 8100-2 §4.11.3; an entered value reduces the demand and is recorded as attested. Pulley rotational inertia is taken as zero; including it would slightly increase the calculated demand.		

Clause: ISO 8100-2:2026 §4.13.6.1.2 Formulae (24)–(27) (friction f), §4.13.6.1.3 Formula (28) (μ_{brake}), §4.11.2 (available traction $e^{(f \cdot \alpha)}$), §4.11.3 Formulae (29)/(30) (static loading $T1/T2$), §4.11.2.3 (stalled $T1/T2$), §4.11.2.2 / Annex C C.3–C.6 (dynamic emergency-braking $T1/T2$)

✓ **TRACTION**

loading & braking must grip · stalled must slip

TRACTION – available vs demand		
Loading MUST GRIP	$grip \geq 1.36$	✓ GRIPS 1.788
Emergency braking MUST GRIP	$grip \geq 1.46$	✓ GRIPS 1.638
Stalled / buffer MUST SLIP	$slip \leq 14.48$	✓ SLIPS 3.196
Bar = available $e^{(f \cdot \alpha)}$ · line = demand $T1/T2$. Grip rows must reach the line; stalled must stay under it (arrowhead points to the safe side).		

B2 · ROPE LIFE – BENDING FATIGUE		custom rope · Feyrer 2015
Force factors $fS1 \cdot fS2 \cdot fS3 \cdot fS4$	1.525	combined force factor
$fS1 \cdot fS2 \cdot fS3 \cdot fS4 = 1.050 \times 1.010 \times 1.250 \times 1.150 = 1.525$		
Rope force S / $S0$ / ΔS	11,929 N	$S0$ 7,414 · ΔS 4,515
$\Delta S = S - S0 = 11,929 - 7,414 = 4,515$ N		
Force-increase $fS5$	1.258	Feyrer Eq 3.69 (one-sided – conservative)
$fS5 = 1 + \text{num/den}$ (Eq 3.69), $\text{num} = (1.31 - 0.0014 \cdot aT \cdot \Delta S/d^2) \cdot (1.1 \cdot \Delta S/d^2 - 0.1 \cdot S/d^2) \cdot aT$, $\text{den} = 145000 \cdot (\delta/d) \cdot (d/Dt) + 600 \cdot (\delta/d) + 0.2 \cdot aT \cdot S/d^2$; aT 2.220 · S/d^2 73.957 · $\Delta S/d^2$ 27.993 · d/Dt 0.0208 · d/δ 17.0 = $1 + (63.52)/(245.8) = 1.258$		
Equivalent force S_{equ}	15,011 N	$S_{\text{equ}} = fS5 \cdot S$
$S_{\text{equ}} = fS5 \cdot S = 1.258 \times 11,929 = 15,011$ N		
Bending length l	3,387 mm	$l = \max(\text{accel route, floor pitch})$
$l = \max(v^2/(2a) \cdot 1000 = 1,581 \text{ mm}, \text{travel/floors} = 3,387 \text{ mm}) = 3,387 \text{ mm}$		
Groove factor $fN3$ (Table 3.15)	0.200	undercut $\beta = 90^\circ$
Round and deflector grooves are evaluated at the Feyrer reference $r/d = 0.53$ ($fN3 = 1.00$, the only published 1.00 point). For looser groove geometries the calculated service life may be nonconservative. A measured r/d may be entered via the attested override on the groove card.		
Endurance factor fC	1.000	Feyrer endurance factor (by core)
Feyrer N-cycles regression (Eq 3.55): $\lg N = b0 + (b1 + b3 \cdot \lg(D/d)) \cdot \text{loadFactor} + b2 \cdot \lg(D/d) + \lg Fd + \lg Fl$		
$b0$ -2.064 · $b1$ 1.588 · $b2$ 8.056 · $b3$ -2.577 · $\lg Fd$ 0.060 · $\lg Fl$ -0.053 · $\text{loadFactor}(S_{\text{equ}})$ 1.969		

Combined bend: $\lg N = -2.064 + (1.588 + -2.577 \times 1.681) \times 1.969 + 8.056 \times 1.681 + 0.060 + -0.053 \rightarrow N = 1.21 \times 10^6$

$\text{loadFactor} = \lg(S_{\text{equ}}/d^2) - 0.4 \cdot \lg(R/1770) = 1.969$ (gradeTerm 0.000); simple/reverse bends use $\lg(S/d^2) \rightarrow \text{loadFactor}$ 1.869

Bending element	n	D/d	fN2	fN3	N mean	N 10th
Combined	1	48.0	1.000	0.200	1.21×10^6	4.30×10^5
Rope class	W-IWRC			Feyrer construction class		
Damage per trip Σ(wi/Ni)	4.12×10^-6			Palmgren-Miner (Eq 3.70)		
damage = Σ ni / N_groove,i where N_groove = N · fN2 · fN3 · fC (fC 1.000); summed over the bend rows above -> 4.12×10^-6						
Trips to discard Z_GF	2.43×10^5 trips			Z_GF = 1 / damage		
Holeschak factor f_GF	0.443			nF^a (Office)		
f_GF = nF^a = 18^-0.282 = 0.443						
Cycles to discard Z_A (mean)	5.48×10^5 cyc			Z_A = Z_GF / f_GF (Eq 3.92)		
Z_A = Z_GF / f_GF = 2.43×10^5 / 0.443 = 5.48×10^5 cyc						
Z_A10 (10th percentile)	1.94×10^5 cyc			Feyrer Table 3.14 (b10 scatter)		
Service life T_AT (mean)	7.5 yr			Z_A / (trips · 365)		
T_AT = Z_A / (trips/day × 365) = 5.48×10^5 / (200 × 365) = 7.5 yr						
Service life T_A10T (10th-pct, design)	2.7 yr			Z_A10 / (trips · 365)		
T_A10T = Z_A10 / (trips/day × 365) = 1.94×10^5 / (200 × 365) = 2.7 yr						

ROPE LIFE – predicted service life

Predicted service life 2.7–7.5 yr. 10th-percentile estimate 2.7 yr; mean estimate 7.5 yr. Use the 10th-percentile value for planning. Engineering estimate only – no code acceptance criterion is applied.



The lower value is the 10th-percentile estimate; the upper value is the mean estimate. Both are derived from the same bending-fatigue model (Feyrer b10 scatter). No code acceptance limit is applied.

- Feyrer bending-fatigue / Palmgren-Miner estimate. Engineering estimate only; no code acceptance criterion is applied.
- Does not account for sheave material hardness, groove surface quality, lubrication state or sheave-bearing condition.
- fs5 fluctuating-tension is applied one-sided (conservative). fN1 lubrication = 1.0 (well-lubricated assumed).
- Assumes correct installation, alignment within fleet-angle limits, and rope discard at the modeled criterion.
- Predicted life scales with the operating profile (floors, trips/day, building type). Verify these inputs.

- Rope construction: Feyrer's bending-endurance constants are published only for 6- and 8-strand ropes. Ropes with more than 8 strands are credited 8-strand endurance – conservative, as the extra strands are not extrapolated.
- Groove fatigue factor f_{N3} is tabulated by Feyrer for undercut grooves 75–105° and V-grooves 35–45°. Angles outside these interpolate to the round-groove reference or clamp to the nearest published value (not extrapolated).
- The endurance regression applies within Feyrer's tested ranges (rope class, D/d, rope tension). Results outside the published test ranges should be treated as extrapolations.

Clause: Feyrer 2015 (2nd ed.) Eq. 3.55/3.69/3.92; Palmgren-Miner (Eq 3.70)

B3 · GROOVE PRESSURE

informational – no pass/fail

Groove type U-undercut -> pressure model selected accordingly. p_0 is the round-seat reference pressure.

Seat geometry (entered)	$\beta = 90^\circ$ $\gamma = 35^\circ$	Undercut angle β / V-included angle γ – drive the friction model and ψ
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Max line pull $S_{\max}$	9,322.33 N	Worst-case rope tension (full car, lowest landing)
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Round-seat reference p_0	2.408 N/mm ²	$p_0 = 2 \cdot S_{\max} / (d \cdot D)$ – Feyrer Eq 3.27a
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$$p_0 = 2 \cdot S_{\max} / (d \cdot D) = 2 \times 9,322.33 / (12.70 \times 609.6) = 2.408 \text{ N/mm}^2$$

Geometry factor ψ	5.302	$\gamma_1 = \beta/2 = 45.0^\circ$, $\gamma_2 = 90 - \gamma/2 = 72.5^\circ$ – Feyrer §3.1.7.2 Eq 3.31 (Donandt)
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$$\psi = \cos \gamma_1 / (0.25 \cdot \sin 2\gamma_2 + 0.5 \cdot \gamma_2 - 0.25 \cdot \sin 2\gamma_1 - 0.5 \cdot \gamma_1), \gamma_1 = 45.0^\circ, \gamma_2 = 72.5^\circ \text{ (angles in rad for the linear terms)}$$

$$= 5.302$$

Specific pressure $k_{\max}$	12.768 N/mm ²	$k_{\max} = \psi \cdot p_0$ – undercut (Feyrer §3.1.7.2 Eq 3.31)
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$$k_{\max} = \psi \cdot p_0 = 5.302 \times 2.408 = 12.768 \text{ N/mm}^2$$

Reported specific pressure	12.768 N/mm ²	undercut $k_{\max}$
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No code acceptance limit is applied. Specific groove pressure is reported for durability and wear comparison. undercut concentrates pressure $\psi \times$ above the round p_0 (Donandt Eq 3.31).

Clause: Feyrer 2015 (2nd ed.) §3.1.7.2 Eq 3.31 (Donandt; $\psi \cdot p_0$ undercut) – no code pressure limit (ISO 8100-2 / A17.1-A17.6)

B4 · ROPE DYNAMICS – RESONANCE SCREEN

Inputs (longest rope): M 5,443 kg · nsr 6 · msr 0.685 kg/m · E 77,000 N/mm² · A 73.7 mm² · L 63.40 m · gn 9.807 m/s²

Lateral f_1 / f_2 / f_3 (lowest)	0.909 Hz	f_2 1.819 · f_3 2.728
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$$f_1 = (1/2L) \cdot \sqrt{M \cdot gn / (nsr \cdot msr) + L \cdot gn/2} = (1/(2 \times 63.40)) \cdot \sqrt{5,443 \times 9.807 / (6 \times 0.685) + 63.40 \times 9.807/2} = 0.909 \text{ Hz}$$

$$f_2 = 2f_1 = 1.819 \text{ Hz} \quad f_3 = 3f_1 = 2.728 \text{ Hz}$$

Longitudinal f (lowest)	1.581 Hz	Bounce mode (longest rope)
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$$f = (1/2\pi) \cdot \sqrt{nsr \cdot E \cdot A / (L \cdot M)} = (1/2\pi) \cdot \sqrt{6 \times 77,000 \times 73.7 / (63.40 \times 5,443)} = 1.581 \text{ Hz}$$

Lateral f_1 / long f (top)	23.379 Hz	long 8.062 Hz (shortest rope L 2.44 m)
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Sheave 1× · once per rev	0.928 Hz	coincidence
$1\times = i \cdot V / (\pi \cdot Dt) = 1 \times 1.778 / (\pi \times 0.6096) = 0.928 \text{ Hz} \cdot 2\times = 2 \times 0.928 = 1.857$		
Sheave 2× · twice per rev	1.857 Hz	coincidence
Building / other coincidence	clear	clear (other)
Frequency separation ϵ	0.005	<<1 -> quasi-stationary valid (snapshot OK)
$\epsilon = V / (2\pi \cdot f1 \cdot L) = 1.778 / (2\pi \times 0.909 \times 63.40) = 0.005$		

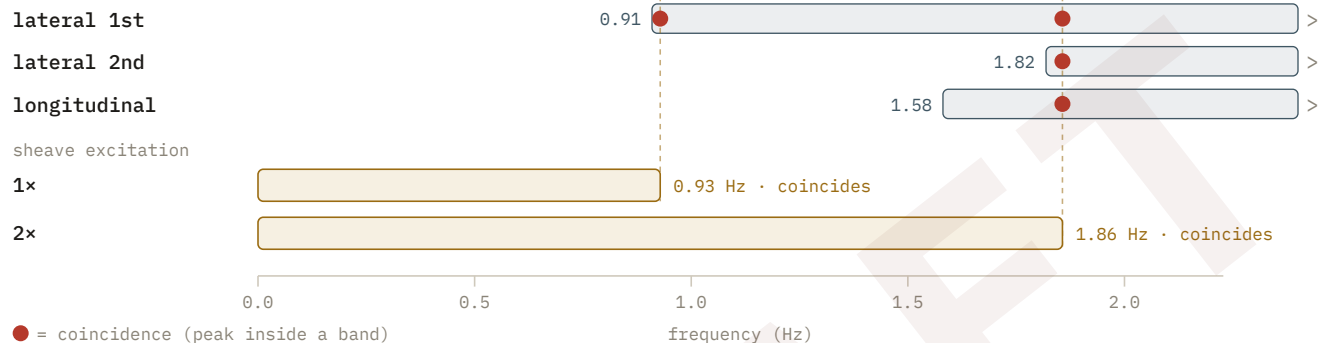
**MONITOR**

Frequency crossing identified (1× sheave, 2× sheave). This screening calculation identifies frequency crossings only; it does not predict vibration amplitude or duration. Review the identified excitation frequencies.

DYNAMICS – resonance map

1× intersects the lateral-1st rope-mode frequency range mid-travel; 2× intersects the lateral-1st, 1 longitudinal and lateral-2nd rope-mode frequency ranges mid-travel.

rope-mode sweep bands – each rises to its top-landing value



Snapshot valid: $\epsilon = 0.005$ ✓ – quasi-stationary validity ratio (is the snapshot frequency valid), NOT the resonance gap.

Resonance map: rope-mode sweep bands (top – each starts at its lowest-landing frequency and rises right to its top-landing value, off the axis) versus sheave-excitation harmonics (bottom – 0 -> peak). A dashed guide and a dot on a band mark a mid-travel coincidence (the peak lands inside that band). Green = clears every band; amber = enters one or more. lateral 3rd (2.73 Hz) above range, clear.

The two sheave rows are its first two rotational harmonics: 1× is one excitation per revolution (eccentricity / imbalance), 2× is two per revolution (out-of-roundness / ovality). Both are screened because a real sheave can carry either imperfection, and either frequency can coincide with a rope mode.

[1] Lateral (string) frequencies use Sun's rope-weight correction: $f = (n/2L) \sqrt{M \cdot g / (nsr \cdot msr) + L \cdot g / 2}$ (Eq 5). The $+L \cdot g / 2$ term (half the rope's own weight) raises the frequency above the bare-string value and makes it fall off less steeply with length – important for long, high-rise ropes.

[2] Longitudinal (axial bounce) fundamental: $f = (1/2\pi) \sqrt{nsr \cdot E \cdot A / (L \cdot M)}$ (Eq 1). The car bounces on nsr ropes in parallel, so the axial stiffness is $nsr \cdot E \cdot A / L$ (A is per-rope); the source eigenvalue Eq 13 reduces to this in the fundamental limit. Harmonics also exist (Eq 12); only the fundamental is shown here.

[3] Frequencies are computed at the lowest landing (longest rope = lowest frequency) and the top landing (shortest rope = highest), and swept between. Transient resonance occurs where a rope frequency crosses an excitation – characteristically near the top, where the rising frequencies meet the excitations.

[4] Quasi-stationary check (ϵ , Eq 8): when $\epsilon \ll 1$ the moving car can be treated as stationary at each position, so the snapshot frequencies are valid. ϵ is small for all normal speeds (the paper's worst case at 12 m/s was 0.067).

[5] Building sway: tall buildings sway at low frequency in wind (~0.1–0.3 Hz); if a long rope's fundamental coincides, resonant rope sway can result (Sun 1995). Enter the building's sway frequency if known; mitigation hardware is covered by A17.1 §2.30 (sway control guides).

[6] Sheave excitation uses the ROPE speed over the sheave ($i \cdot V$), not the car speed – so for 2:1 it is doubled. The "other excitation" input may be used to evaluate an additional specified excitation frequency (drive or mains harmonic, guide-joint passing frequency = $V \div$ rail length, etc.).

[7] Scope: resonance and sway only. Per Bethlehem EL-TB-11, field "noisy rope" reports frequently originate from rope-to-groove size mismatch, differential groove depths, sheave misalignment or bearing condition, none of which are determined by a frequency calculation. Where calculated rope-mode frequencies remain separated from the entered excitation frequencies, no coincidence is reported.

[8] Undamped natural frequencies (steel rope damping is small, per the source). 2:1 uses L = travel + overhead for the car-side run; verify against the installed rope length if a precise high-rise figure is needed.

Sources: P. Andrew & S. Kaczmarczyk, "Rope Dynamics," Elevator World, July 2011 (Eq 1 longitudinal, Eq 5 lateral w/ Sun correction, Eq 8 ϵ). L. Sun, "Building Sway and Elevator Rope Vibration," Elevator World 1995. S. Kaczmarczyk, J. Sound & Vibration 208(2) 1997. K. Feyrer, Wire Ropes (2015) §2.2.4. Field context: Bethlehem Elevator Rope Technical Bulletin 11 (Vibration). Mitigation hardware: ASME A17.1 §2.30 (Sway Control Guides).

The screening method identifies frequency crossings only and does not distinguish a transient crossing from sustained resonance. It is intentionally conservative and may identify crossings that do not result in significant rope response. Investigate identified excitation sources.

Clause: Andrew & Kaczmarczyk EW Jul 2011; Feyrer Eq 2.57/2.67/2.68

B5 · ROPE ELONGATION

Rope class · metallic area A	73.71 mm ²	8-strand · steel core
$A = C \cdot d^2 = 0.4570 \times 12.70^2 = 73.71 \text{ mm}^2$		
Rope modulus E	77,000 N/mm ²	Effective rope elastic modulus – class lookup (CIMA modulus table)
Rated-load force T	17,793 N	$T = (Q/i) \cdot gn$
$T = (Q/i) \cdot gn = (1,814.4 / 1) \times 9.80665 = 17,793 \text{ N}$		
Suspension length L	63,398 mm	travel + overhead
$L = \text{travel} + \text{overhead} = 60,960 + 2,438 = 63,398 \text{ mm}$		
Elastic stretch δ	1.304 in	$\delta = T \cdot L / (E \cdot A \cdot n)$ – Hooke, shared across n ropes
$\delta = T \cdot L / (E \cdot A \cdot n) = 17,793 \times 63,398 / (77,000 \times 73.71 \times 6) = 33.1 \text{ mm} = 1.304 \text{ in}$		
$\text{Elastic stretch per foot} = 0.0063 \text{ in/ft}$		
Constructional stretch (low / high)	3.744 in	0.15–0.35% of L – permanent bedding-in
$\text{Constructional} = 0.15\text{--}0.35\% \times L = 3.744\text{--}8.736 \text{ in}$		

Total elongation (low / high)	5.048 in	total = δ + constructional · high 10.040 in
$Total = \delta + constructional = 1.304 + 3.744 = 5.048 \text{ in (low)} \dots 10.040 \text{ in (high)}$		
[1] Elastic stretch is calculated using rated load only (Eq 6: $T=(Q/i) \cdot gn$). Empty car, hoist ropes, compensation and travelling cable are permanently suspended, so their stretch forms part of the constructional (permanent) stretch rather than the temporary levelling swing. The elastic load case is therefore smaller than the Sf T_max load case.		
[2] L is the car-side rope length at the lowest landing = travel + overhead (+ another travel if the machine is bottom-mounted, which doubles the run). This matches the physics of the leveling drop and the standard car-side rope-length basis (travel + overhead, with drive-height and bottom-mount terms as applicable). If overhead is left blank it is treated as 0 and L is flagged as a lower bound. For 2:1, the car-side path is longer – verify against installed rope length if a precise figure is needed.		
[3] Area factor C and modulus E are tabulated by 6- vs 8-strand class: ≤ 7 strands use the 6×19 row, ≥ 8 use the 8×19 row. These constants depend chiefly on strand count and core type, not the exact wire count.		
[4] Modulus E varies with construction, manufacturer and load range, and rises ~20% once used / pre-stretched. Elevators run in a low load range (~2-10% of MBF) where E sits at the lower end, so the 0-20% values are used. Elastic stretch scales inversely with E; treat the figure as a nominal estimate.		
[5] Constructional stretch cannot be calculated exactly and is reported as a percentage range of loaded rope length (permanent, bedding-in over the first weeks of service). Manufacturer data should be used where available. Heavier load and more bends push toward the high end; pre-stretching reduces it (BRIDON). Field rule of thumb ~ 3.5 mm per metre.		
[6] Construction and core are taken from the entered rope data. Elongation is not calculated for catalogue-only rope selections.		
[7] Some elevator stretch calculations report a different quantity – they load the rope with car + $\frac{1}{2}$ rated load + $\frac{1}{2}$ rope weight (Tload) rather than rated load alone – so their stretch figure is larger; this sheet follows the cited elevator source (rated-load swing) by design. The rope-LENGTH basis matches that convention (see note 2).		
[8] Out of scope: thermal expansion (Eq 8) and plastic/permanent stretch (only above the yield point – unrealizable at a suspension Sf ≥ 12).		
Sources: M. Hadjzaman, "Traction Elevators: A Comparative Study on Wire Rope Stretch," Elevator World, Feb 2018 (Eq 1 / 3 / 6). W. Scheunemann, W. Vogel & T. Barthel, "Steel Wire Ropes for Traction Elevators," Elevator World, July-Sept 2009 (elongation behaviour, rope-length). Bethlehem / Wirerope Works EL_TB_05. K. Feyrer, Wire Ropes (2015). EN 12385-2 & ISO 17893 (area factor). ISO 12076 (rope modulus test). AISI Wire Rope Users' Manual; BRIDON; CIMAF; Gustav Wolf (VDI 2358).		
Clause: Hadjzaman EW Feb 2018 (EN 12385-2 / ISO 17893); CIMAF modulus; AISI WRUM constructional		

ROPE & CABLE ORDER ESTIMATE

PLANNING FIGURE – NOT PART OF THE CALCULATION

Reeving configuration	Overhead 1:1	from the job's roping + machine position
Rise / travel	200' -0"	job input
Overhead	8' -0"	top landing (floor level) -> centre of the drive sheave · job input
Pit depth	8' -0"	order-estimate input
Governor rope	Yes	order-estimate input
Allowance – hoist extra	25.00 ft	default (field left blank) · added to every hoist rope before rounding
Allowance – double wrap	20.00 ft	default (field left blank) · not applied – single-wrap drive
Allowance – governor rope	20.00 ft	default (field left blank) · added to the governor-rope run
Allowance – compensation	50.00 ft	default (field left blank) · not used – no compensation
Round increment	10 ft	order lengths round UP to this
Order per hoist rope	250 ft	base 224.00 + extra 25.00, rounded up
<i>Order/rope = ROUNDUP((224.00 + 25.00) / 10) × 10 = 250 ft</i>		
Hoist ropes – total	1,500 ft	250 ft × 6 ropes · ~ 690 lb
Governor rope	460 ft	qty 1 · +20.00 ft governor allowance (default (field left blank); not the hoist extra) · weight per governor-rope spec
<i>Governor = ROUNDUP((2×200.00 + 2×8.00 + 2×8.00 + 20.00 allowance) / 10) × 10 = 460 ft</i>		
Rope & cable order estimate (planning figure). Overhead is measured from the top landing to the centre of the drive sheave; a double-wrap allowance is added when the drive is double-wrapped. Every allowance is stated above with its source (default or entered). Verify against the GA layout and rope-shop practice before ordering.		

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