Cat Ladders for Singapore Buildings: Choosing Between Aluminium, SS304 and Galvanised Mild Steel

Companion to the EN10025 Steel Grades Comparison workbook — for designers and contractors specifying fixed access ladders to BS EN ISO 14122-4, SS 570 and SCDF requirements.

Why this blog matters

A "cat ladder" is the industry term for a **fixed vertical ladder** — the kind found on roof access points, water tanks, plant decks, mezzanines, telecom shelters, and SCDF-mandated rescue hatches in storey shelters. It looks simple: two stiles, a row of rungs, a few wall brackets. But it is a **life-safety component**: a person at the top of a 6 m run can be carrying 100 kg of body + tools, and the ladder must stay rigid even after a slip-fall arrest event.

Three materials dominate the market in Singapore:

1. **Aluminium** (typically alloy **6061-T6** or **6063-T6**) — light, corrosion-resistant, premium price.
2. **Stainless Steel SS304** — strong, corrosion-resistant, medium-heavy weight, premium price.
3. **Galvanised Mild Steel** — usually a **S235 / S275 / S355** structural section, hot-dip galvanised to **BS EN ISO 1461**. Cheapest, heaviest, requires re-coating long-term.

This blog walks through the **structural strength differences** that drive the choice, with reference to **BS EN ISO 14122-4** (the EN ladder design code), **SS 570** (Singapore PPE/fall-protection standard), and **SCDF storey-shelter cat-ladder requirements**.

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1. The design loads every cat ladder must meet

The starting point for any selection is **what the ladder must carry**. Per **BS EN ISO 14122-4:2016 (Safety of machinery — Permanent means of access — Part 4: Fixed ladders)** (ISO 14122-4:2016, ITeH preview):

Load case	Magnitude	Where applied
Rung load **F1** (one person)	**1.5 kN**	Mid-rung, distributed over 100 mm
Stile load **F2** (one person)	**1.5 kN**	Each stile, 2 m apart
Fall-arrester anchor load	**≥ 6 kN**	Top anchor, when device activates
Each anchorage point to wall	**≥ 3 kN** per stile (two-stile ladder)	Each of four anchor points
Single-stile ladder	**≥ 6 kN**	Through the single stile

For comparison, **OSHA 29 CFR 1910.23(d)** requires every fixed ladder to support **at least 250 lb (≈ 1.13 kN)** concentrated load on any rung in any direction (OSHA 29 CFR 1910.23, full text).

In Singapore, the **SCDF Technical Requirements for Storey Shelters 2021, Clause 2.11.2** mandates that for the specific cat ladder that provides **access through the rescue hatch opening of a Civil Defence Storey Shelter (SS)** — i.e. the ladder fixed to the SS wall inside the shelter chamber that lets occupants escape upward through the ceiling hatch — **"the cat-ladder shall be made of either stainless steel or aluminium or equivalent"**, and **"the mounting connections of cat-ladder to the SS wall shall be designed to withstand shock loads of at least 12.5 g in all directions"** (SCDF Cl. 2.11.2). For an 80 kg cat ladder, 12.5 g translates to a **10 kN shock load** in each direction — a very onerous requirement that filters out flimsy materials immediately. **Note that this clause is narrowly scoped**: it governs the SS rescue-hatch ladder only — **not** roof-access cat ladders, plant-deck ladders, water-tank ladders, or solar PV ladders elsewhere on the same building. For those, the governing standards are EN ISO 14122-4 (geometry/loading) and EN 1992-4 (anchorage).

> **Takeaway:** SCDF actively excludes mild steel for shelter cat ladders. For non-shelter applications (factory roof access, water tanks, plant rooms), all three materials are permitted, but **EN 14122-4 is the load benchmark the designer must satisfy regardless of material**.

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2. Material strength compared

Drawing on data from the **Cross-Material Strength** and **Strength-to-Weight** sheets in the workbook, plus ASTM/EN handbook values:

Property	Galv MS (S275)	Galv MS (S355)	SS304	Aluminium 6063-T6	Aluminium 6061-T6
Yield strength fy	**275 MPa**	**355 MPa**	**210 MPa**	**170 MPa**[1]	**240 MPa**[1]
Ultimate tensile strength	410–560 MPa	470–630 MPa	515–720 MPa	215 MPa	260 MPa
Density ρ	7,850 kg/m³	7,850 kg/m³	7,900 kg/m³	**2,700 kg/m³**	**2,700 kg/m³**
Modulus of elasticity E	**210 GPa**	210 GPa	200 GPa	**69 GPa**	69 GPa
Strength-to-weight (fy/ρ)	35 kN·m/kg	45 kN·m/kg	26 kN·m/kg	**79 kN·m/kg**	**102 kN·m/kg**
EN partial factor γM0	1.00	1.00	**1.10** (EN 1993-1-4)	1.10 (EN 1999)	1.10 (EN 1999)
Elongation at break	22–26%	22%	**45%**	12%	12%

Sources: workbook Cross-Material Strength sheet, Kloeckner 6061 vs 6063, AMD Supply.

[1] **Yield-strength basis** — values shown are **EN 755-2 minimum 0.2% proof stress**, which Eurocode design must use: 6063-T6 = 170 MPa (≤ 10 mm) / 160 MPa (10–25 mm) and 6061-T6 = 240 MPa (≤ 12.5 mm) (EN 755-2 mechanical properties, Aluminium-Guide). The often-quoted **214 MPa (6063-T6)** and **276 MPa (6061-T6)** are ASTM B221 typical values used in U.S. design (Kloeckner Metals). For Singapore work under Eurocode, use the EN minima.

What this means for ladder design

(a) Stiffness — not strength — usually governs cat ladder design. A cat ladder is a long slender column subject to load away from the wall. Deflection and lateral stability govern far more than yield. Aluminium has only **one-third** the stiffness of steel (E = 69 GPa vs 210 GPa) (Kloeckner Metals, 6061 vs 6063 aluminium). So although **6061-T6 has yield strength (276 MPa) comparable to S275 mild steel** (Kloeckner Metals, 6061-T6 yield), an aluminium stile must be **deeper or thicker** to match the same deflection limit. EN ISO 14122-4 implicitly recognises this: most aluminium ladders use thicker box-section stiles (e.g. 50×50×4 mm hollow) instead of the typical 50×10 mm flat stile used for steel.

(b) Stainless SS304 has lower yield, higher elongation, and a 10% strength penalty. SS304 yields at 210 MPa, slightly below even S235 mild steel. It also carries a higher partial factor (**γM0 = 1.10** per EN 1993-1-4 vs **1.00** for carbon steel per EN 1993-1-1) — meaning the designer must reduce its capacity by another ~10% in calculations. To compensate, SS304 ladders are usually fabricated from **slightly thicker stiles** than mild-steel equivalents. The pay-off is **45% elongation** (more than double mild steel's 22–26%), which gives SS304 superb energy absorption during a fall-arrest event.

(c) Galvanised mild steel has the best raw strength — when uncorroded. S275 galvanised is the workhorse material for industrial cat ladders. Yield is high, stiffness is high, and the section can be slim. The catch is **corrosion**: once the galvanising is breached the underlying steel rusts rapidly, and section loss erodes capacity. For an outdoor ladder in Singapore (humid, rain, salt-laden coastal air), a typical 80 µm hot-dip

galvanising lasts **15–25 years in C3 environments**, but only **5–10 years in C5-M coastal/industrial** zones (BS EN ISO 14713-1).

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3. Worked example — a 4 m roof access cat ladder

Let's apply EN ISO 14122-4 loads to a typical **4 m rise, 400 mm rung width, 4-bracket fixing** ladder, and see what stile section each material needs.

Design action on each stile (worst case, person at mid-height):

- F2 = 1.5 kN per stile, applied 2 m apart → bending moment in stile ≈ **0.75 kN·m**
- Plus self-weight bending and a 1.0 kN service torque from a slip event (typical assumption)
- Total design moment **MEd ≈ 1.0 kN·m**

Required plastic section modulus Wpl,Rd:

$$W_{pl,Rd} \geq (M_{Ed} \cdot \gamma_{M0}) / (f_y)$$

Material	fy	γM0	Required Wpl	Typical stile section
Galv MS S275	275 MPa	1.00	**3.6 cm³**	**40 × 8 mm flat** (Wpl = 3.2 cm³) — slightly under, use 50×8 (Wpl = 5.0 cm³)
SS304	210 MPa	1.10	**5.2 cm³**	**50 × 10 mm flat** (Wpl = 6.25 cm³) ✓
Al 6061-T6	276 MPa	1.10	**4.0 cm³**	**50 × 50 × 4 mm SHS** (Wpl = 5.4 cm³) ✓ — but check deflection
Al 6063-T6	214 MPa	1.10	**5.1 cm³**	**60 × 60 × 4 mm SHS** (Wpl = 7.4 cm³) ✓

Now the interesting part — **deflection** under F2 = 1.5 kN at mid-stile, simply supported between brackets at 1.5 m centres:

$$\delta = (F\, L^3) / (48\, E\, I)$$

For the same stile sections above:

Material	I (cm⁴)	E (GPa)	δ at 1.5 kN over L = 1.5 m
MS S275, 50×8 flat	8.3	210	**0.5 mm**
SS304, 50×10 flat	10.4	200	**0.6 mm**
Al 6061-T6, 50×50×4 SHS	22.0	69	**0.7 mm**

> The **aluminium SHS** is the bulkiest section but achieves comparable deflection because of its larger second moment of area I — the engineer trades section depth for the lower modulus.

This is exactly why aluminium cat ladders **look chunkier** than steel ones for the same span — and why a "spindly" aluminium ladder is a red flag for under-design.

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4. Suitability summary — when to pick each material

Application	Best choice	Why
Inside SCDF storey shelter, accessing rescue hatch (Cl. 2.11.2 only)	**SS304 or Aluminium** (mandated)	Mild steel not permitted **for this specific ladder**; 12.5 g shock requirement on SS wall anchorage
Indoor plant room, dry environment	**Galv MS**	Cheapest, longest life when dry, easy to weld and modify
Coastal / marine roof access	**SS316** preferred, **SS304 acceptable**	Galv life < 10 years; aluminium pits in chloride splash
Petrochemical / industrial C5 zone	**SS316**	Galv corrodes; SS304 risks pitting from chlorides + chemicals
Lightweight rooftop ladder, low load	**Aluminium 6061-T6**	Easy to install single-handed; no painting; rust-free
Heavy industrial cat ladder, frequent traffic	**Galv MS S355**	Highest stiffness, lowest cost, easy to inspect and repair
Food / pharma plant	**SS304/SS316**	Hygienic, no flaking paint, easy to clean

5. Compliance snapshot — what to specify on the drawing

Whichever material you pick, the drawing should call up:

- **Geometry**: Rung spacing **225–300 mm constant** (EN 14122-4 §5.2.2.2). For a **two-stile** ladder, clear width between stiles **400–600 mm** (§5.2.2.3); for a **single-stile** ladder the central tread width is **150–250 mm** (§5.3.2.4). **Tread surface flat and ≥ 20 mm wide; circular rungs are NOT permitted** (§5.2.2.4) (ISO 14122-4:2016).
- **Clearance**: ≥ 650 mm in front of rungs, ≥ 200 mm behind (EN 14122-4 §4.1.3) (ISO 14122-4 clearance). 7-inch (≈ 178 mm) minimum behind for OSHA-aligned design (OSHA 29 CFR 1910.23(d)(4)).
- **Fall protection trigger**: required when **overall falling height ≥ 3,000 mm** per EN ISO 14122-4 §4.2.1, via either a safety cage **or** a fall arrester (the two cannot be combined) (ISO 14122-4 §4.3 fall protection trigger). Under OSHA, the trigger is **24 ft (7.3 m)** above lower level; new fixed ladders erected on or after **19 November 2018** must use a personal fall-arrest system or ladder safety system — **cages are no longer accepted as fall protection on new installations**, only on pre-existing ones (OSHA letter of interpretation, 1910.28(b)(9)(i)).
- **Single-flight / rest-platform limits**: For ladder systems > 10,000 mm overall, EN ISO 14122-4 §4.4 requires either staggered flights of ≤ 6,000 mm height with a cage, or fall-arrester-equipped flights with **rest platforms at ≤ 12,000 mm** intervals, or a single fall-arrester-equipped flight with rest platforms (additional intermediate rest platforms at ≤ 12 m) (ISO 14122-4 §4.4 fall-arrester rest platforms) (Hailo H-50 guide, EN 14122-4 12 m platform spacing).
- **Material grade + finish**:
  - Galv MS: "S275JR to BS EN 10025-2, hot-dip galvanised to BS EN ISO 1461, minimum coating 85 µm"
  - SS304: "1.4301 to BS EN 10088-2, polished to 240-grit, all welds passivated"
  - Aluminium: "6061-T6 or 6063-T6 to BS EN 573-3, anodised 25 µm minimum"
- **Anchorage design**: each anchor **≥ 3 kN** (or ≥ 6 kN single-stile) per EN ISO 14122-4. The **12.5 g shock check** applies **only** to a cat ladder inside an SCDF Storey Shelter providing access through the SS rescue hatch — not to roof-access or solar PV ladders.
- **Welding**: SS304 use 308L/308LSi filler, avoid sensitisation 425–850 °C (workbook Weldability sheet). MS: E7018 or equivalent. Aluminium: 4043 or 5356 filler depending on alloy.

6. Cost reality (Singapore market, indicative 2024–2026)

For a typical **4 m, 2-stile cat ladder with 4 wall brackets, no cage**, fabricated and installed:

Material	Indicative cost	Service life (Singapore tropical)
Galv MS S275	**S$ 350–500**	15–25 years inland; 5–10 years coastal
SS304	**S$ 1,200–1,800**	25+ years inland; 15–20 years coastal
SS316	**S$ 1,600–2,400**	30+ years coastal; 50+ inland
Aluminium 6061-T6	**S$ 1,000–1,500**	30+ years (no rust, anodising lasts)

When you divide **cost by service life**, SS304 and aluminium often beat galvanised mild steel for **outdoor coastal applications**. For dry indoor plant access, galv MS remains the most cost-effective.

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7. Bottom line

- **For sheer strength-per-millimetre, S355 galvanised mild steel still wins** — but durability is the limiting factor in Singapore's climate.
- **SS304 is the best all-round structural choice**, especially for life-safety installations where the ladder must remain trustworthy for decades.
- **Aluminium is the lightest and most corrosion-immune option**, but the lower stiffness (E = 69 GPa) forces designers to use thicker stiles — a "skinny" aluminium ladder is almost certainly under-designed.
- **SCDF Cl. 2.11.2 mandates SS or aluminium — only — for the specific cat ladder inside a Civil Defence Storey Shelter that accesses the rescue hatch opening**, with a 12.5 g shock-load anchorage check on the SS wall. This is far more onerous than the EN 14122-4 baseline, and it is **narrowly scoped**: roof-access and solar PV cat ladders on the same building are not regulated by Cl. 2.11.2 and may use any of the three materials based on the durability/cost trade-offs above.
- Whatever material you pick, **specify to BS EN ISO 14122-4** for geometry and loads, and call up the matching coating standard.

The next blog in this series covers **how the ladder is anchored to the wall** — concrete vs AAC vs cement block — and the engineering details that prevent the most common failure mode: anchor pull-out.

References cited inline. Workbook source: EN10025_Steel_Grades_Comparison.xlsx (Cross-Material Strength, Strength-to-Weight, Design Standards, Weldability sheets).