TIMBER FRAME vs LIGHT GAUGE STEEL FRAME INSULATION PERFORMANCE

The following is a comparison of insulation systems between timber framing and light gauge steel framing construction methods. The comparisons are made while also keeping the SANS Building Regulations in mind.

In South Africa, timber-frame and light gauge steel (LGS) frame insulation performance is regulated by the energy efficiency code - **SANS 10400-XA** (Energy Usage in Buildings). [1, 2, 3]

Because timber frame and light gauge steel structures are legally classified as "lightweight construction", they do not possess the natural thermal mass of brick and concrete. Therefore, SANS 10400-XA strictly mandates higher thermal resistance (**R-values**) for lightweight systems to prevent aggressive temperature fluctuations inside the home. [3, 4, 5, 6]

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1. Roof and Ceiling Insulation Requirements

The roof assembly accounts for the highest thermal loss and gain in a timber or LGS structure. SANS 10400-XA dictates compliance based on South Africa's **climatic zones** (Zones 1 through 6). [7]

- **Total Minimum R-Value:** Most climatic zones require a total roof/ceiling system R-value of **3.7m²K/W** (square meters Kelvin per Watt), while Zone 5 (temperate coastal areas like Durban) requires a minimum of **2.7m²K/W** [7]
- **Physical Thickness:** To achieve these values using standard glass mineral wool or polyester batts (e.g., Isotherm or Aerolite), you must install an uncompressed thickness between **100 mm and 135 mm**. [3, 7]
- **No Compression Allowed:** Insulation must not be compressed over timber brandering or rafters. Compressing insulation by just a few centimetres can lead to a devastating **performance loss of up to 72%**. [7, 8, 9]
- **Thermal Bridging Barriers:** If you use corrugated or profile metal roof sheeting over metal purlins on a timber truss, a thermal barrier material with a minimum R-value of **0.2 m²K/W** must be placed directly between the sheeting and the structure. [10]
- **Fire Wall Boundaries:** Per SANS 10400-L (Roofs), no combustible insulation or tile underlay is legally permitted to cross over a masonry fire separating wall. Trusses must be physically split at the barrier. [11]

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2. Wall Insulation Requirements

Because timber studs create a hollow cavity, the building envelope relies heavily on "cavity-fill" dynamics to achieve a comfortable internal climate. [12, 13]

- **Total System R-Value:** SANS 10400-XA mandates that lightweight external walls achieve a total minimum R-value depending on the zone (typically aiming between **2.2 and 2.9 m²K/W** total path resistance). [6]
- **Standard Cavity Framing:** Deemed-to-satisfy regulations typically call for standard **38 mm x 114 mm Grade 5 or Grade 7 structural timber studs** spaced at 400 mm or 450 mm centre-to-centre. [5, 12, 14, 15]
- **The Insulation Layer:** The 114 mm framing cavity must be filled with high-density thermal insulation slabs (such as Isover Cavitybatt or equivalent rock wool). A minimum thickness of **100 mm** inside the external wall cavity is the standard benchmark for structural compliance. [12]
- **Vapour and Weather Barriers:** SANS 10082 requires an approved weather-resistant membrane (such as Sisalation or a breathable vapour barrier) to be wrapped around the exterior face of the timber

framing/OSB board before the external cladding is attached. This prevents wind-driven moisture from compromising the dry thermal properties of your interior insulation cavity. [12, 16]

- **Internal Cladding:** The inside face of the timber framing must be sealed with a fire-rated or standard layer like **12.5 mm skimmed plasterboard (Rhinoboard)**. This acts as the interior thermal boundary and safe flame-retardant layer. [12, 17]

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3. Summary Reference Table

Building Element	SANS 10400-XA Focus	Deemed-to-Satisfy Application
Roof & Ceiling	Total System R-Value: **2.7 to 3.7**	**100 mm–135 mm** uncompressed bulk insulation blankets.
External Walls	Lightweight continuous thermal layer	**100 mm** Cavity batt insulation + vapour barrier wrap + 12.5 mm gypsum board interior.
Thermal Bridging	Structural junction mitigation	**R-0.2 barrier** strips under metal roof sheeting elements.

For certified project plan submissions, you can reference official energy compliance breakdowns outlined in the TIPSASA Thermal Insulation Guide or evaluate professional timber engineering specs directly via the Institute of Timber Construction South Africa (ITC-SA). [5, 18]

From a pure, raw material perspective, **timber is a vastly superior insulator to Light Gauge Steel (LGS)** because steel creates a massive, highly conductive thermal bridge from the outside of the building to the inside. [1]

However, the construction industry has developed specific engineering workarounds for steel. When comparing how the two materials perform in the real world under **SANS 10400-XA**, the dynamics shift based on how you design the wall system. [2]

1. The Raw Material Reality (The Thermal Bridge)

- **Timber:** Wood has a naturally high thermal resistance (R-value). A standard 114mm timber stud acts as a natural insulator. The heat or cold struggling to pass through the wall meets resistance both from the cavity insulation and the timber studs themselves. [3, 4, 5, 6, 7]
- **Light Gauge Steel:** Steel is an excellent conductor of heat. Even though you pack the 90mm or 150mm steel stud cavity with high-density insulation, the heat takes the path of least resistance. It travels directly through the thin steel studs, bypassing the insulation entirely. This is called **thermal bridging**, and it can slash the overall effectiveness of your cavity insulation by **up to 50%**. [8, 9, 10, 11, 12]

2. How SANS 10400-XA Forces Steel to Compensate

Because steel conducts heat so easily, you cannot legally build a steel-frame house in South Africa by simply putting insulation *inside* the studs. To pass building regulations, LGS framing requires an **External Thermal Insulation Composite System (ETICS)**. [13, 14, 15]

- **The Steel Workaround:** To break the thermal bond, builders must wrap the *entire outside* of the steel frame in a continuous layer of **Expanded Polystyrene (EPS)** or rigid **Polyisocyanurate (PIR) foam board** (usually 25mm to 50mm thick) before adding the external cladding.

- **The Result:** This external foam layer acts as a thermal break, stopping the heat from ever reaching the steel framework. [16, 17, 18, 19]

3. The Verdict: Which is Better?

- **Timber Frame is Easier and Safer:** Timber is more forgiving. If there is a small gap in your installation, the wood framing still blocks a lot of heat transfer. It naturally feels warmer to the touch and creates a stable interior climate with fewer complicated layers. [20, 21, 22, 23, 24]
- **Steel Frame is More Engineered:** Once you add the mandatory external rigid foam insulation to a steel frame, it can actually achieve a *higher* total system R-value than a standard timber wall. However, this makes steel frame construction significantly more expensive, requiring precise installation to prevent condensation and moisture traps inside the walls. [25, 26, 27, 28, 29]

Why Use 38x152mm instead of 38x114mm Studs for External and Load Bearing walls

Choosing **38 mm x 152 mm timber studs** for your external and load-bearing walls provides exceptional structural integrity and naturally superior thermal insulating depth compared to Light Gauge Steel (LGS).

Here is how these two systems compare directly on cost per square metre and Fire Resistance Ratings (FRR) under South African building regulations (**SANS 10400-T** and **SANS 10400-XA**). [1, 2]

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1. Cost per Square Metre Comparison

In South Africa, the finished turn-key building cost for a residential home can generally ranges from **R9 000 to R18 000+ per m²**, depending on finishes and location. When isolating the framing, structural wall system, and mandatory insulation layers: [3, 4]

- **Timber Frame (38x152mm):**
  - Using **38x152mm Grade 5/7 structural timber** raises the raw timber volume cost by roughly 25%–30% compared to standard 38x114mm studs.
  - However, it remains highly cost-effective because carpentry labour is widely available, modifications on-site are cheap, and the extra depth allows you to use standard, affordable 135mm bulk insulation blankets inside the cavity to easily smash your **SANS 10400-XA** thermal targets. [5, 6, 7]
- **Light Gauge Steel (LGS) Framework:**
  - The raw steel frame kit itself is typically **10% to 20% more expensive** upfront than timber framing.
  - Specialized LGS assembly labour commands a premium rate over standard carpenters.
  - Crucially, because steel creates a destructive thermal bridge, you cannot just insulate the cavity. You are legally required to buy an **External Thermal Insulation Composite System (ETICS)**—such as a continuous wrap of 25mm 50mm high-density Expanded Polystyrene (EPS) board—on the outside of the frame before cladding. This extra step drives up the wall assembly material cost significantly. [5, 8, 9, 10, 11]

Financial Verdict: Timber framing with 38x152mm studs will save you roughly **10% to 15% on structural wall system costs** compared to an LGS framework that has been legally insulated to pass South African energy codes.

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2. Fire Resistance Rating (FRR) Comparison

A common misconception is that steel framing is automatically safer in a fire because steel doesn't burn. **SANS 10400-T (Fire Protection)** evaluates the structural assembly as a whole system, not just the raw material. [12, 13, 14, 15]

- **Timber Frame (38x152mm System):**
  - **The Law:** SANS 10400-T requires a minimum **30-minute FRR** for structural timber walls in standard domestic double-storey or single-storey homes (Occupancies H3/H4).
  - **Performance:** Timber burns at a slow, predictable charring rate (roughly 0.65mm per minute). A heavy 38x152mm stud retains its internal load-bearing core structural integrity under intense heat far longer than thinner 114mm timber studs.
  - **Achieving 30–60 Mins:** By lining the interior face with a single layer of **12.5 or 15 mm fire-rated gypsum plasterboard (Fireshield/Rhinoboard)** and packing the 152mm cavity with non-combustible rockwool or high-density glasswool, the wall easily achieves a certified **30 to 60-minute fire rating**. [16, 17, 18, 19]
- **Light Gauge Steel (LGS System):**
  - **The Law:** Requires the same 30 to 60-minute structural boundary rating depending on proximity to the property line.
  - **Performance:** While steel is non-combustible, light gauge cold-formed steel (0.8mm–1.2mm thick) behaves terribly when directly exposed to fire temperatures exceeding 550°C. It loses its structural stiffness rapidly, causing sudden, catastrophic buckling.
  - **Achieving 30–60 Mins:** To achieve its fire rating, LGS depends entirely on its gypsum board cladding shield to prevent heat from touching the steel. If the drywall cracks or is breached, the steel frame fails faster than a heavy 152mm timber stud. [13, 15, 16, 20, 21]

Fire Safety Verdict: Both systems pass SANS 10400-T safety standards through defensive drywall cladding. However, the **38x152mm timber stud provides a safer, more predictable structural burn rate** if a fire breaks through the interior cladding layer. [13, 15]

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3. Structural Comparison Summary

Metric	Timber Frame (38x152mm Studs)	Light Gauge Steel (LGS Frame)
Material Cost	Lower; local structural pine is highly cost-competitive.	Higher; linked to fluctuating global steel commodity pricing.
Insulation Cost	Cheaper; deep 152mm cavity holds high-volume, low-cost bulk batts.	Higher; mandates an expensive external rigid foam envelope to break thermal bridging.
Labour Availability	Highly accessible; standard local carpenters can erect it.	Restricted; requires specialized LGS framing teams and tools.
SANS 10400-T Fire Behavior	**Slow & predictable.** Retains core strength due to wood's natural charring layer.	**Rapid buckling risk.** Steel loses structural integrity quickly at high temperatures if breached.

Addressing one of the major, well-known shortcut in the low-cost South African building sector.

The companies advertising building a light gauge steel house from R7 000 per m² most probably skip the external insulation in order to achieve that cheap price point by **cutting critical environmental corners and breaking the law under SANS 10400-XA.** [1]

If you choose to build with one of these low-cost LGS operators, you will face severe long-term consequences.

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1. How They Cheat the R7 000/m² Price Point

To advertise a turn-key build at R7 000/m² in South Africa, builders must strip out every premium component. They do this by eliminating the expensive External Thermal Insulation Composite System (ETICS)—the continuous outer wrap of rigid foam—and using only basic cavity insulation batts. [2]

By skipping the external wrap, they save massively on:

- **Material costs:** No specialized rigid Expanded Polystyrene (EPS) boards.
- **Labour costs:** No time-consuming external rendering, mesh, and base-coating over the foam.
- **Detailing costs:** No specialized flashings around windows to accommodate thick exterior walls.

2. The Internal Consequence: The "Ghosting" Effect

When a builder leaves a direct steel bridge from the outside cladding to the inside drywall, the consequences inside the home are immediate and severe:

- **Thermal Bridging Failure:** Because steel is highly conductive, the indoor drywall directly touching the steel studs becomes freezing cold in winter and boiling hot in summer.
- **The "Ghosting" Effect:** Warm, humid indoor air hits those freezing cold vertical drywall lines. The moisture instantly condenses into wet strips on the walls. Airborne dust and soot stick to these wet tracks, creating ugly, permanent grey vertical stripes (ghosting) along every single wall stud. [3]
- **Severe Mould Growth:** Within one or two winters, these damp, uninsulated steel lines turn into breeding grounds for black mould, right inside the living spaces. [4, 5]
- **High Electric Bills:** The house acts like an energy sieve, making your heating and cooling costs astronomically high.

3. The Legal Issue: Municipal & NHBRC Rejection

Building without a continuous external thermal break on an LGS home **fails the Deemed-to-Satisfy rules of SANS 10400-XA.** [6, 7]

If a builder submits plans showing *only* cavity insulation in a steel frame, a competent municipal building inspector or an independent engineer will reject the energy compliance report. Furthermore, the **NHBRC** (National Home Builders Registration Council) can refuse to sign off on the structural enrolment, preventing you from getting an occupation certificate or securing a bank bond. [8]

Why a 38x152mm Timber Plan is Superior

This is exactly why your plan to use **38 mm x 152 mm timber studs** is so smart.

To make a steel frame perform legally and comfortably, you have to buy a cheap frame and then spend a fortune "fixing" its thermal flaws with external plastic foams. With a 152 mm timber stud, the wood *is* the thermal break. You can legally fill that massive 152 mm cavity with cheap, thick, local glasswool or polyester insulation and comfortably pass building regulations without needing any expensive external foam work.

<u>Why a 38x152mm Timber Frame Wall is Superior to an LGS Wall</u>

A 38x152mm Load bearing and/or external wall with cladding, airgap, Tyvek House wrap on top of 15mm OSB and 135mm Rockwool for insulation in the cavities is a premium, brilliantly engineered high-spec wall design.

Visually, a **227 mm wall** will give your home the heavy, substantial look of a traditional double-skin brick wall (which sits around 230 mm–240 mm with interior plaster), but it will outperform brick lightyears over in terms of insulation and moisture control.

Layer-by-Layer Technical Evaluation

- **Nutec Cladding (9 mm):** Fiber-cement board is highly durable and impact-resistant. Using 9 mm instead of the standard 6 mm adds great rigidity and limits warping over time. [1, 2, 3]
- **38x38 mm Brandering Cavity:** This is elite building practice. Creating a **38 mm ventilated rainscreen cavity** ensures that if any wind-driven moisture penetrates the Nutec joins, it drains harmlessly down the air gap instead of soaking into your structure.
- **Tyvek Housewrap (0.6 mm) & OSB (15 mm):** Placing the breathable membrane directly over a heavy 15 mm OSB sheathing layer is perfect. The OSB provides immense racking strength to your 152 mm studs, while the Tyvek protects the wood from liquid water while letting internal vapor escape.
- **152 mm Stud Cavity:** This is your primary thermal engine. A 152 mm deep space allows you to install top-tier **135 mm or 145 mm uncompressed insulation batts**. This layout will easily push your total wall R-value well past **3.5 to 4.0 $m^2 \cdot K/W$**, which completely smashes the minimum requirements of SANS 10400-XA across all South African climatic zones.
- **Plasterboard (12.5 mm):** Gluing and screwing the interior drywall ensures a flush, stable finish that reduces screw-pops as the timber framework expands and contracts slightly with the seasons.

Important Detailing Considerations for a 227 mm Wall

Because your walls are significantly thicker than standard lightweight builds, keep these implementation details in mind:

1. **Window and Door Reveals:** Standard off-the-shelf window frames are designed for thinner walls. You will need to specify **extended custom timber window reveals** or deep flashings to bridge the full 227 mm distance from the inside plasterboard to the outside Nutec edge.
2. **Cavity Vermin Barriers:** Because you have a 38 mm open air cavity behind the Nutec board, you must install a perforated **aluminium or stainless steel vermin mesh** at the very bottom and top of the wall. This lets air circulate but stops mice, geckos, and bees from nesting inside the gap.
3. **Internal Vapor Vapor Drive:** Ensure your insulation batts do not have an attached foil layer facing the wrong way. In South Africa's climate, a separate vapor retarder layer is generally not needed if using a highly breathable external wrap like Tyvek.

<u>Insulation Material</u>

Using **Rockwool (stone wool)** inside a 152 mm cavity is an exceptional choice. It is the absolute highest-performing insulation media you can use for this specific wall layout.

When combining Rockwool with your 227 mm thick wall assembly, you achieve a level of thermal, acoustic, and fire performance that surpasses almost any standard residential building in South Africa.

Why Rockwool elevates your 152 mm wall design

- **SANS 10400-T Fire Safety Excellence:** Rockwool is completely non-combustible and can withstand temperatures exceeding **1,000°C** without melting. In a 152 mm thickness, it acts as a massive fire barrier inside your walls. Combined with your 12.5 mm interior plasterboard, this setup will easily achieve a certified **60-to-90-minute Fire Resistance Rating (FRR)**, far exceeding the standard 30-minute legal minimum. [1, 2]
- **Massive Thermal R-Value:** High-density Rockwool typically has a thermal conductivity (λ) of around 0.035 to 0.038 $W/m\cdot K$. A 150 mm thick Rockwool layer gives you a standalone insulation R-value of roughly **3.9 to 4.2 $m^2 \cdot K/W$**. When you add your OSB, air cavity, and plasterboard, your total wall

system R-value will sit near **4.5 to 5.0 m² · K/W**. This is roughly **double** the minimum requirement for SANS 10400-XA, making your home incredibly energy efficient. [3, 4]

- **Acoustic Deadening:** Because Rockwool is highly dense and made of spun volcanic rock, it traps sound waves better than light glasswool or polyester. Your home will feel solid and completely isolated from external noises like wind, heavy rain hitting the Nutec, or barking dogs. [5, 6, 7]
- **No Slumping or Sagging:** Cheap, lightweight insulation blankets can sag inside a vertical wall cavity over 10 to 15 years, leaving an uninsulated cold gap at the top of the wall. High-density Rockwool batts are rigid and friction-fit tightly between your 38 mm studs, ensuring they stay perfectly in place for the lifetime of the building. [8]

Legal Requirements:

The legal requirement that dictates how Light Gauge Steel (LGS) framing must be insulated comes from the interplay between two specific South African National Standards: **SANS 517** (Light Code-Formed Steel Framing in Building) and **SANS 10400-XA** (Energy Usage in Buildings). [1, 2]

While a builder might try to argue that they put insulation in the cavity, the law looks at the performance of the **total wall system**, explicitly accounting for thermal bridging. [3, 4]

The exact rules and legal mechanisms that stop low-cost LGS operators from skipping external insulation include:

1. The Core Law: SANS 10400-XA (Section 4.2.1)

SANS 10400-XA splits the building envelope into walls lighter than 270 kg/m² (Lightweight Construction) and walls heavier than 270 kg/m² (Masonry). [4, 5]

- **The Rule:** For a lightweight external wall system (which includes LGS and timber), the code mandates a minimum **Total System R-value** based on your energy zone. For instance, in colder or hotter zones (Zones 1, 2, 6, and 7), the wall must achieve a minimum total R-value of **2.2 m² · K/W**. In coastal or temperate zones (Zones 3, 4, and 5), it must hit **1.9 m² · K/W**. [2, 4]

2. The Calculation Catch: SANS 517 (Section 9)

This is where the law explicitly traps cheap steel frame builders. SANS 517 is the dedicated national building code compiled specifically for low-rise light steel frame structures. [2]

- **The Rule:** Section 9 of SANS 517 explicitly states that when calculating the total R-value of an LGS wall system, **the calculation must account for thermal bridging caused by the steel studs**. [6]
- **The Mathematical Reality:** Because steel has a highly destructive thermal conductivity layer, if you only insulate *inside* the 90 mm steel cavity, the "Effective R-value" of that cavity insulation drops by roughly **50% to 60%** because heat leaks through the studs. [7, 8]
- A 90 mm fiberglass cavity batt might have a material R-value of 2.0 on the packaging, but when calculated inside an LGS frame per SANS 517 rules, its *effective* system R-value plummets to roughly **0.8 to 1.0**. Because 1.0 is far below the legally required 1.9 or 2.2 system minimum, **the wall legally fails compliance**. [4, 9]

3. The Mandatory Remedy: ETICS (External Thermal Insulation Composite System)

Because the math in SANS 517 proves that cavity insulation alone cannot meet SANS 10400-XA targets, the standard "Deemed-to-Satisfy" building pathway requires the installation of an **ETICS layer**. [10]

- The law states that to stop thermal bridging, a continuous, uninterrupted thermal break—such as rigid Expanded Polystyrene (EPS) or Polyisocyanurate (PIR) board—must be mechanically fastened to the *outside* of the steel frame. This layer must completely isolate the steel from the external cladding. [3, 10, 11, 12]

How R7 000/m² Builders Bypass the Law (Illegally)

If the law is this strict, how are these low-cost builders passing municipal plans? They generally use one of two loopholes:

1. **Fraudulent Plan Submission:** The builder or draftsman submits a plan showing a cross-section that *includes* external insulation or a complex system to get the council's approval stamp. Once the building starts, they simply don't buy or install the exterior foam boards, counting on the municipal building inspector not knowing enough about LGS requirements to check the wall layers before cladding goes up.
2. **Abusing "Rational Design" Assessments:** Under the National Building Regulations, if a builder cannot meet the prescriptive "Deemed-to-Satisfy" codes, they can hire an independent engineer to complete a **Rational Design**. The engineer uses software to simulate the home's total annual energy usage. Unscrupulous operators press engineers to manipulate data (e.g., assuming massive solar panel arrays or unrealistically high-spec roof systems) to offset the illegal, poorly insulated steel walls on paper. [13]

Ultimately, building an LGS home without a continuous external thermal break violates **SANS 517** and **SANS 10400-XA**. Your 38x152mm timber frame plan avoids this entire mess because wood doesn't suffer from high-conductivity bridging, allowing your cavity insulation to operate at 100% legal efficiency. [2, 7, 14]

NOTE:

The above information is compiled from SANS code and internet sites. Should you find any errors in the above information please contact us with the correct information in order to update the document.

Above information is to be used as a guideline in order to make an informed decision