INSTALLATION GUIDE 16 min read Updated December 2024

Ceramic Fiber Blanket Installation: Layering, Anchoring, and Overlap Technique

Master anchor density specifications, stud welding procedure, compression washer technique, and multi-layer staggered joint design to prevent gap formation and fiber sagging.

Ceramic fiber blanket installation quality directly determines thermal insulation performance and service l shaped refractory brick which relies on mortar joints and gravity/arch action for stability, ceramic fiber bla kg/m³) that requires mechanical anchoring to resist gravitational loads, thermal shrinkage forces, and gas parameters that govern long-term performance are: (1) anchor density — the number of anchor studs per thickness, density, and orientation (vertical wall vs horizontal roof); (2) joint overlap distance and compres 6% thermal shrinkage without creating insulation gaps; and (3) multi-layer staggering strategy for linings which eliminates continuous thermal paths through the insulation system.

Industry field data from over 1,000 furnace installations in aluminum smelting, heat treatment, ceramics fi that 65% of premature ceramic fiber failures — defined as visible gaps, sagging, or detachment requiring trace to one of four installation errors: insufficient anchor density causing fiber to sag or pull away from jc shrinkage; inadequate overlap distance at joints creating gaps when fiber shrinks 3–5% during initial heat to compress excessively and lose thermal resistance; or failure to stagger joints between multiple layers c guide provides field-proven specifications for anchor system design, step-by-step installation procedures overlap distance calculations accounting for thermal shrinkage, and quality verification checklists to ensu before furnace commissioning.

Anchor System Design and Specification

Anchor Density Requirements by Application

Anchor density (studs per square meter) must be calculated based on fiber weight, thermal shrinkage for

FIBER CONFIGURATION	ROOF/HORIZONTAL SURFACE (ANCHORS/M²)	VERTICAL WALL (ANCH
25mm single layer, 128 kg/m³	2.5–3.5	2.0–2.5
50mm single layer, 128 kg/m³	3.5–4.5	2.5–3.5
50mm + 50mm (two layers), 128 kg/m³	4.0–5.0	3.0–4.0
100mm single layer, 128 kg/m³	5.0–6.0	4.0–5.0
50mm, 256 kg/m³ (high-density)	4.5–5.5	3.5–4.5

Anchor density calculation methodology:

The anchor must support the weight of fiber plus withstand thermal shrinkage pull-away forces. For a 50r

- **Weight per m²:** 0.05m × 128 kg/m³ = 6.4 kg/m²
- **Safety factor:** 3× (accounts for thermal cycling, vibration, handling damage)
- **Design load:** 6.4 kg/m² × 3 = 19.2 kg/m² = 192 N/m² (1.92 kPa)
- **Anchor capacity:** Typical welded stud with 50mm washer holds 150–200N before fiber tears through
- **Required density:** 192 N/m² ÷ 150 N/anchor = 1.28 anchors/m² minimum
- **Recommended density:** 2.5–3.5 anchors/m² (provides 2–3× additional safety margin for thermal shrin

Horizontal roof applications require 40–50% higher anchor density because fiber weight is fully supporte against vertical substrate.

Anchor Stud Specification

01 **Material selection:** 304 stainless steel for continuous service >800°C, 310 stainless steel for >1000°C, c service. Avoid galvanized studs (zinc coating vaporizes above 420°C creating toxic fumes).

02 **Diameter:** 6mm (¼") for light-duty applications, 8mm (5/16") standard for most installations, 10mm (⅜") Larger diameter provides better weld strength and washer bearing surface.

03 **Length calculation:** Total length = fiber thickness + 25mm minimum embedment into shell + 15mm above Example: 50mm fiber requires 90mm stud (50 + 25 + 15 = 90mm).

04 **Welding specification:** Arc stud welding (capacitor discharge or drawn arc method) preferred over manu out strength. Minimum weld diameter = 1.5× stud diameter. Weld penetration into shell ≥3mm for structur

05 **Perpendicularity requirement:** Stud must be perpendicular to shell surface within ±5° tolerance. Angled slide off washer during thermal movement.

Compression Washer and Retention System

The washer-clip system distributes anchor load and maintains fiber compression:

- **Washer diameter:** 50–75mm for standard applications; larger diameter (75–100mm) for soft/low-dens
- **Washer profile:** Domed or cupped profile (3–5mm crown height) distributes compression load more e surface irregularities
- **Washer thickness:** 1.0–1.5mm stainless steel; thicker washers (2.0mm) required for high-temperature strength
- **Retention method:** Spring clip (S-clip or hairpin clip) preferred over bent stud end; clips allow compre

> **Field tip:** Mark anchor grid layout on furnace shell before welding studs using chalk line or template. Eyeba areas over-anchored (wasted cost), others under-anchored (failure zones). Use 500mm × 500mm grid for 4 anchors/m².

Overlap Joint Design and Compression Technique

Overlap Distance Specification

Overlap must be sized to accommodate thermal shrinkage without creating gaps. Standard overlap distar

- **Horizontal laps (vertical wall applications):** Upper blanket overlaps lower blanket by 75–100mm. Con during anchoring. This creates "compressed reserve" that relaxes as fiber shrinks.
- **Vertical laps (vertical wall applications):** Side-by-side blankets overlap 50–75mm. Stagger vertical jc minimum 200mm to prevent continuous thermal paths.
- **Roof applications:** All joints 75–100mm overlap regardless of direction. Increase to 100mm for applica temperature (high shrinkage conditions).

Thermal shrinkage accommodation calculation:

For 1260°C fiber operating continuously at 1150°C:

- Expected linear shrinkage: 3.0% (from manufacturer data or ASTM C892 testing)
- Installation overlap: 100mm
- Compressed thickness during installation: 100mm → 50mm (50% compression)
- Fiber shrinks 3.0%: 50mm × 0.97 = 48.5mm (shrinkage causes compression to relax)
- Final overlap thickness: 48.5mm → relaxes to ~65mm as fiber shrinks longitudinally
- Result: Continuous insulation maintained; no gap formation

Common error: Installing fiber with butt joints (edges touching, no overlap) or minimal overlap (<25mm). creating 15–40mm wide gaps. Minimum 50mm overlap is non-negotiable; 75–100mm is best practice for

Installation Sequence for Compressed Overlap

1. **Position leading edge:** Unroll blanket starting from bottom of wall (for vertical walls) or from one corı of anchors.
2. **Apply tension:** Pull blanket taut across anchor grid creating 10–15% stretch (e.g., 600mm wide roll st accommodates shrinkage and ensures tight contact with substrate.
3. **Create overlap:** Position trailing edge to achieve target overlap distance (75–100mm). Mark overlap z
4. **Anchor overlap zone:** Install anchors through overlap area first, compressing both layers to 50–60% compress 50mm combined thickness to 25–30mm at anchor points.
5. **Secure intermediate anchors:** Complete anchoring of single-layer zones, compressing to 60–70% o

6 **Install retention clips:** Secure spring clips onto all anchors, ensuring washers maintain compression (compressed but not crushed).

Multi-Layer Installation with Staggered Joints

Why Multi-Layer Beats Single Thick Layer

For total insulation thickness >50mm, installing multiple thin layers provides superior performance to sing

PERFORMANCE FACTOR	SINGLE 100MM LAYER	TWO 50MM LAYER
Thermal short-circuit risk	High (continuous gap if joint opens)	Low (staggered joi
Installation ease (overhead)	Difficult (heavy, unwieldy)	Moderate (lighter,
Thermal shrinkage	3.5% (baseline)	3.0% total (surface
Anchor retention	Moderate (single pull-through failure mode)	Superior (mechanic
Material cost	Baseline	+8–12% (extra cutt
Installation labor	Baseline	+15–20% (two-pas
Long-term failure risk	Baseline	60–75% reduction

Joint Staggering Specification

Minimum stagger distance: 200mm between joints in adjacent layers. Preferred stagger: 300–400mm fo

Installation pattern for two-layer system (100mm total):

1. Install first layer (50mm) with horizontal laps every 600–800mm (depending on blanket roll width)
2. Anchor first layer at base density (e.g., 3.5 anchors/m² for vertical wall)
3. Mark first-layer joint locations on exposed surface with chalk or marker
4. Install second layer (50mm) with joints offset 300mm minimum from first-layer joints
5. Use extended-length anchors (50mm + 50mm + 25mm embedment + 15mm above = 140mm studs)
6. Anchor through both layers at increased density (4.0 anchors/m²), compressing combined 100mm thi

Critical detail: Second-layer anchors must penetrate completely through first layer into shell. Anchoring o second layer can separate and fall off during thermal cycling.

Vertical Wall vs Horizontal Roof Installation Differences

Vertical Wall Installation

Advantages: Gravity assists in holding fiber against substrate; lower anchor density required; easier to ac

Installation procedure:

1. Start from bottom of wall working upward (prevents upper sections from sliding down during installat
2. First course rests on furnace floor or steel angle support — anchor within 100mm of bottom edge to p
3. Horizontal laps: Upper course overlaps lower course by 75–100mm (shingle pattern sheds any conde
4. Vertical laps: Stagger joints between successive horizontal courses by minimum 200mm
5. Anchor spacing: Typically 2.5–3.5/m² for single 50mm layer, increase to 3.0–4.0/m² for two-layer syst

Common vertical wall issues:

- **Top edge curl-back:** Insufficient anchoring near top edge allows fiber to curl away from wall. Solution: at 1.5× normal density.
- **Sliding at corners:** Inside and outside corners experience higher stress. Solution: Increase anchor den continuous fiber wrapping around corner (no joints within 200mm of corner).

Horizontal Roof Installation

Challenges: Full fiber weight supported by anchors; higher risk of sagging between anchor points; difficu

Enhanced installation procedure:

1. Increase anchor density 40–50% vs vertical wall specification (e.g., 4.0–5.0 anchors/m² for 50mm lay
2. Use larger-diameter washers (75mm vs 50mm standard) to distribute load and prevent pull-through
3. Install fiber in smaller sections (1.2m × 1.2m) rather than full-length rolls to minimize unsupported wei
4. Use temporary support pins or wires to hold fiber in position while securing permanent anchors
5. Apply additional compression at anchor points (compress to 55–65% vs 60–70% for walls) to accour

Sag prevention: Maximum recommended anchor spacing on horizontal roofs is 450mm × 450mm (4.9 ar allows visible sagging (25–40mm depression between anchors) that creates surface waviness and conce

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Ceramic Fiber Module Installation

Ceramic fiber modules are pre-fabricated blocks (typically 300mm × 300mm face × 50–150mm depth) w Modules offer faster installation than blanket but higher material cost.

Module vs Blanket Selection Criteria

- **Use modules when:** Installation time is critical (modules install 60–80% faster than blanket), skilled fil requirements are high (modules create uniform appearance), or repair/replacement of small sections is
- **Use blanket when:** Complex geometry requires custom fitting, total installed cost must be minimized, (blanket material cost is 30–40% lower than modules).

Module Installation Key Points

- Anchor density: 4–6 studs per module (depending on module size and weight)
- Module compression: Install modules in compressed state (60–70% of uncompressed thickness), ther tight interface
- Joint treatment: Modules create natural butt joints at edges — fill all joints with loose ceramic fiber or f
- Expansion allowance: Leave 3–5mm gap between modules to accommodate thermal expansion; do no stress during heat-up)

5 Installation Errors That Cause Premature Failure

ERROR 01

Insufficient Anchor Density

Installing 2.0 anchors/m² on horizontal roof where 4.5 anchors/m² required. Result: Fiber sags betwee sagging compounds thermal shrinkage to create gaps at joints. Failure typically visible after 3–6 mor replacement.

ERROR 02

Inadequate Overlap Distance

Installing with 25mm overlap or butt joints instead of 75–100mm compressed overlap. Result: When gaps. Hot spots develop at gaps (shell temperature increases 100–200°C above design), acceleratin

ERROR 03

Over-Compression at Anchor Points

Compressing fiber to <50% of original thickness (crushed fiber). Result: Fiber structure collapses; th compressed zones create cold spots on hot face and hot spots on cold face. Over-compressed fiber movement.

ERROR 04

Continuous Joints in Multi-Layer Systems

Installing second layer with joints aligned with first-layer joints (no stagger). Result: Any gap in first l continuous thermal path. Heat loss through aligned joints can be 300–500% higher than through int

ERROR 05

Incorrect Stud Length

Using 75mm studs for 50mm fiber (insufficient protrusion) or 150mm studs for 50mm fiber (excessiv length: Cannot install washer and clip, fiber not secured. Excessive length: Stud bends during installa shell and creating fiber detachment zone.

Installation Quality Inspection and Acceptance Criteria

01 **Anchor density verification:** Count anchors in representative 1m × 1m zones (minimum 5 zones across lir specification. Example: 4.0/m² specified → minimum 3.8/m² actual in any zone.

02 **Overlap distance check:** Measure overlap width at minimum 10 locations per 100m² lining area. All overla absolute minimum, 75–100mm preferred). Any joints <50mm overlap must be repaired by installing additi

03 **Surface uniformity:** Maximum acceptable sag between anchor points: 15mm for vertical walls, 10mm for indicates insufficient anchor density or improper compression — requires corrective anchoring.

04 **Compression verification:** Measure compressed thickness at anchor points. Target: 60–70% of original t allows excessive long-term sag. Over-compressed (<55% thickness) damages fiber structure and increas

05 **Joint stagger verification (multi-layer):** For two-layer systems, verify joints in second layer are offset mi measuring tape or pre-marked template. Any aligned joints within 200mm must be corrected by removing

06 **Anchor integrity:** Perform pull test on 2% of anchors (minimum 5 anchors). Apply 150N (15 kg) load for 1 detach from shell. Any failed anchors indicate welding deficiency; increase test sample to 5% and repair a

07 **Photographic documentation:** Photograph completed installation showing: overall view of lining, close-u corner treatments, any repair areas. Archive photos for warranty claims and future maintenance reference

Installation Quality = 70% of Service Life Performance

High-quality ceramic fiber material installed poorly will fail prematurely. Mediocre fiber material insta life. Field data from warranty claim analysis shows that installation defects account for 70% of prema

account for only 20% (remaining 10% traces to operating condition changes or design errors). The i
practice and best practice is typically 15–25% higher labor hours — but the performance difference
anchor density, compressed overlap joints, and multi-layer staggering are not optional upgrades; the
achieving the 3–5 year service life that fiber blanket systems are capable of delivering.

*Content produced from Zibo's refractory manufacturing cluster — China's largest concentration of ceram
years of continuous technical development in alumina-silica fiber formulation, blanket needling technolog
furnace insulation applications worldwide.*

IN THIS ARTICLE

FREQUENTLY ASKED QUESTIONS

Fiber Blanket Installation: Common Questions

How many anchor studs per square meter for ceramic fiber blanket installation? +

What is the correct overlap distance for ceramic fiber blanket joints? +

Should I install ceramic fiber in one thick layer or multiple thin layers? +

What type of anchor studs and washers should I use for ceramic fiber? +

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