INSTALLATION GUIDE 16 min read Updated January 2024

LCC Castable Installation Guide: Water Ratio, Mixing, Placing, and Curing

Complete step-by-step procedures for low cement castable installation with quality control and common error prevention.

Low cement castable (LCC) installation success depends on precise control of five critical parameters: wa weight), mixing time and method (forced-action mixer for 3–5 minutes), placement and vibration techniqu curing duration (minimum 24 hours at ambient temperature), and controlled dry-out schedule (critical 20 failure analysis data indicates that 47% of castable underperformance traces to installation errors rather t addition (35% of cases), inadequate mixing (28%), and improper dry-out (22%) being the dominant failur

Proper installation requires understanding that LCC is a chemically bonded system — the calcium alumina hydrates in the presence of controlled water to form a hydraulic bond that develops strength over time. T conventional concrete where excess water can be compensated. For LCC, water addition variation of ±0.5 density by 3–5% and hot strength by 15–20%, translating to 20–30% reduction in service life. This guide analysis of over 200 successful installations across cement kiln, steel ladle, and industrial furnace applica

STEP 1 Pre-Installation Preparation

Equipment Checklist

01 **Forced-action mixer** — Planetary or pan mixer required. Drum mixers (cement mixer type) are INADEQUA energy for proper dispersion.

02 **Weighing scale** — Accuracy ±0.1 kg for water measurement. Do NOT measure water by volume (buckets)

03 **Vibration equipment** — External form vibrator (pneumatic or electric) + internal poker vibrator for thick se
optimal.

04 **Formwork** — Steel or plywood, sealed to prevent water leakage. Coat with release agent (light oil or comr

05 **Anchor system** — Stainless steel or heat-resistant alloy anchors welded to shell. Spacing per design (typ
penetration ≥3× anchor diameter.

06 **Temperature monitoring** — Ambient thermometer (affects working time), IR pyrometer for dry-out phase
(>300mm).

Material Storage and Handling

— **Storage conditions:** Keep castable bags in covered, dry area. Humidity >70% over extended periods (

— **Shelf life:** 6 months from production date in proper storage. Verify production date on bags — reject n

— **Bag integrity:** Inspect for tears or moisture damage. Reject bags with hardened lumps (indicates mois

— **Batch consistency:** Use material from same production batch for continuous sections to ensure color

STEP 2 Water Addition and Mixing

Critical: Water Measurement

> **Water addition is the single most critical parameter.** For LCC specified at 5.0% water, adding 5.5% (10% c
> 6% and hot MOR (modulus of rupture) by 18–25%. This translates to 25–35% shorter campaign life. Always
> calibrated scale, never by volume.

Step-by-Step Water Addition Procedure

1. **Verify TDS (Technical Data Sheet) water specification** — Typical range: 4.5–6.0% for LCC, 4.0–5.0%
castable weight.
2. **Weigh dry castable** — Example: 50 kg bag × 5.0% = 2.50 kg water required.

3 **Pre-measure water** — Weigh exact amount in graduated container. Water temperature should be 15–
in cold weather).

4 **Two-stage addition (recommended field practice):**

5 Add 80% of specified water (2.00 kg in example above)

6 Mix for 2 minutes

7 Add remaining 20% (0.50 kg) gradually while observing consistency

8 Mix for additional 2–3 minutes

9 **Consistency check** — Properly mixed LCC should:

10 Flow sluggishly when poured (not liquid, not crumbly)

11 Hold shape briefly when formed into ball, then slowly slump

12 Show wet sheen but no free water on surface

> **Field adjustment rule:** If castable appears too dry after adding specified water, add maximum 0.2% additio
> minute. If still too dry, STOP and contact supplier — material may have absorbed moisture in storage, affect
> over specification under any circumstances.

Mixing Procedure

EQUIPMENT	BATCH SIZE	MIXING TIME	SUITA
Forced-action mixer (planetary)	50–500 kg	3–5 minutes	Excelle
Pan mixer (intensive)	100–1000 kg	4–6 minutes	Excelle
High-intensity drill mixer	10–50 kg	5–7 minutes	Accept
Drum mixer (cement mixer)	Any	—	UNACC

Mixing sequence:

1 Pre-wet mixer with small amount of water, then drain (prevents initial batch from sticking)

2 Load dry castable into mixer

3 Start mixer and add 80% of water over 30–60 seconds

4 Mix for 2 minutes

5 Add remaining 20% water gradually while mixing

6 Mix for additional 2–3 minutes until uniform (total mixing time: 4–5 minutes)

7 Visual inspection: No dry pockets, no segregation, uniform color

STEP 3

Placement and Vibration

Working Time Constraints

LCC working time (from water addition to end of vibration) depends critically on ambient temperature:

AMBIENT TEMPERATURE	WORKING TIME	FIELD PRACTICE
10°C	40–50 minutes	Cold weather — extended working time, s
20°C	25–35 minutes	Ideal conditions — standard procedure
30°C	15–20 minutes	Hot weather — reduce batch size, work q
>35°C	<15 minutes	Extreme heat — consider night work, coo

Critical rule: Once castable begins to stiffen, do NOT add more water to "re-temper" it. This destroys the h strength by 40–60%. Discard stiffened material and mix fresh batch. Plan batch sizes to match crew placen

Placement Procedure

1 **Layer thickness:** Maximum 200mm per lift for proper vibration penetration. For thick sections (>200ı

2 **Pouring technique:** Pour from minimum practical height (≤0.5m) to avoid segregation. Direct pour int movement after placement.

3 **Anchor coverage:** Ensure castable completely surrounds anchors with no voids. Use poker vibrator a

4 **Cold joints:** If work must stop >30 minutes, create proper cold joint:

   5 Finish previous lift with rough surface (drag broom or scraper)

   6 Before resuming, wet surface with light water spray (not saturated)

   7 Continue placing within 24 hours for best bond

Vibration Technique

Vibration serves two purposes: (1) remove entrapped air, (2) achieve proper consolidation and density. I
(aggregate sinks, cement paste rises).

Correct vibration procedure:

- **External form vibration:** Apply vibrator to formwork outer surface. Move systematically every 0.5m. Vi
surface shows wet sheen and air bubbles stop rising.
- **Internal poker vibration (for thick sections >150mm):** Insert poker vertically into castable, spacing 3
withdraw slowly (5–10 seconds insertion, 5–10 seconds withdrawal). Overlap vibration zones by 50mm
- **Vibration endpoint:** Stop when:
  - Surface shows continuous wet sheen (thin layer of water/paste)
  - Large air bubbles stop rising
  - Surface becomes level and smooth
- **Over-vibration signs (STOP immediately if observed):**
  - Excessive bleeding (>2mm water layer on surface)
  - Aggregate segregation visible at edges
  - Castable becomes soupy/liquid

STEP 4

Curing

Curing allows hydraulic bond to develop before thermal exposure. Inadequate curing results in 20–40% lo

Curing Requirements

- **Minimum duration:** 24 hours at ambient temperature (15–25°C). Extend to 36–48 hours if ambient <1
- **Moisture retention:** Keep castable surface damp (not saturated) for first 12–18 hours. Methods:
  - Cover with plastic sheeting (seal edges to trap moisture)
  - Light water spray every 4–6 hours (avoid saturation)
  - Wet burlap covering (maintain dampness)
- **Formwork removal:** Earliest 24 hours after placement for vertical walls. Wait 48 hours for overhead or mechanical damage.
- **Temperature protection:**
  - Winter: Protect from freezing (<5°C). Use heated enclosure or delay installation.
  - Summer: Shade from direct sun. Avoid surface temperatures >40°C during curing.

STEP 5

Controlled Dry-Out (Critical Phase)

Dry-out removes water and develops ceramic bond. This is the most dangerous phase — improper dry-ou the entire lining.

Why Controlled Dry-Out Is Critical

LCC contains 4–6% water after placement:

- **Free water (2–3%):** Physical moisture in pores, evaporates 20–110°C
- **Chemically bound water (2–3%):** In hydrated cement phases (CAH_{10}, C_2AH_8), releases 200–400°C

Heating faster than water can escape generates steam pressure (up to 5 MPa if heated too quickly). This (2–4 MPa), causing explosive spalling.

Standard LCC Dry-Out Schedule

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Phase 1: Free Water Removal (CRITICAL — SLOWEST PHASE)
  20°C → 110°C: Heat at 10°C/hour maximum
  Hold at 110°C: 4–6 hours (essential for complete free water removal)

  Monitoring: Watch for steam emission from openings/vents
              Surface should be completely dry before proceeding

Phase 2: Bound Water Release
  110°C → 200°C: Heat at 10°C/hour
  200°C → 400°C: Heat at 15–20°C/hour

  Chemistry: Dehydration of CAH₁₀ → CA + H₂O (vapor)

Phase 3: Dehydroxylation
  400°C → 600°C: Heat at 20–30°C/hour

Phase 4: Ceramic Bond Formation
  600°C → 1000°C: Heat at 30–50°C/hour
  Hold at 1000°C: 4–6 hours (strength development soak)

  Chemistry: Formation of CA₂, CA₆ ceramic phases

Phase 5: Final Heat-Up to Service Temperature
  1000°C → service temp: 50°C/hour (or faster if design allows)

Total dry-out time from ambient to 1000°C: ~50–70 hours
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Dry-Out Adjustments by Castable Type

CASTABLE TYPE	20–200°C PHASE	REASON
Conventional castable (15–25% cement)	8°C/hour (slower)	Higher wa
LCC (3–8% cement)	10°C/hour (standard)	Moderate
ULCC (<3% cement)	12–15°C/hour (faster possible)	Lower wat
Thick sections (>300mm)	5–8°C/hour (much slower)	Water esc

Monitoring During Dry-Out

- **Temperature measurement:** Use multiple thermocouples embedded at 1/3 and 2/3 depth in thick sect point, not furnace temperature.
- **Visual inspection:** Watch vent holes and openings for steam emission. Heavy steaming indicates too-f
- **Acoustic monitoring:** Listen for cracking sounds. Minor cracking (light popping) is normal. Loud crack temperature.
- **Pressure relief:** Ensure adequate venting. For large furnaces, open inspection ports during 20–200°C

Common Installation Errors and Consequences

ERROR 01

Excessive Water Addition (6.5% vs specified 5.0%)

Consequence: Bulk density drops from 2.50 g/cm³ to 2.38 g/cm³ (5% reduction). Hot MOR at 1200°((worse insulation). Service life reduced 25–35%. **Prevention:** Always weigh water. Train crew that "w concrete."

ERROR 02

Inadequate Mixing (Drum Mixer Used)

Consequence: Non-uniform water distribution creates weak zones. Binder not fully activated. Streng Premature failure in under-mixed areas. **Prevention:** Use only forced-action mixers. Verify mixing tim

ERROR 03

Over-Vibration (Seeking "Perfect" Smooth Surface)

Consequence: Segregation — aggregate sinks to bottom, cement paste concentrates at top. Top lay
Strength reduced 20–30%. **Prevention:** Stop vibration when air bubbles cease and surface shows w
than over-vibrate.

ERROR 04

Insufficient Curing (<12 hours before dry-out start)

Consequence: Hydraulic bond incompletely developed. Thermal stress during heat-up cracks weak
Prevention: Minimum 24 hours ambient curing. Verify surface is hard (thumbnail cannot indent) befo

ERROR 05

Rapid Dry-Out (20°C/hour in 20–200°C phase)

Consequence: Explosive spalling from steam pressure. Can destroy entire lining section in minutes.
Prevention: NEVER exceed 10°C/hour below 200°C. Use temperature controller with alarm. Monitor

Quality Inspection and Acceptance

In-Place Density Test (Core Drilling Method)

After curing (before dry-out), drill 50mm diameter × 100mm deep core sample from non-critical area:

1. Measure core dimensions (diameter, length)
2. Calculate volume: $V = \pi \times (D/2)^2 \times L$
3. Weigh core (dry weight)
4. Calculate density: ρ = Weight / Volume
5. Compare to specification ± acceptable tolerance (typically ±5%)

Example: Core 50mm dia × 100mm long weighs 490g
$V = 3.14 \times 25^2 \times 100 = 196{,}350\ mm^3 = 196.35\ cm^3$
$\rho = 490g / 196.35cm^3 = 2.50\ g/cm^3$

Visual Inspection Criteria

- ✓ **Surface finish:** Uniform color, no dry pockets or segregation visible. Minor surface roughness acceptable
- ✓ **No voids around anchors:** Complete coverage, no gaps >5mm. Use flashlight inspection.
- ✓ **No cracks >0.5mm width:** Hairline cracks (<0.3mm) acceptable. Structural cracks require investigation.
- ✓ **Proper thickness:** Verify with probe or depth gauge. Tolerance typically ±10mm.
- ✓ **Surface hardness (after 24h curing):** Thumbnail cannot indent surface. Rebound hammer reading ≥20 (i

Acceptance Testing (For Critical Applications)

For large or critical installations, consider laboratory testing of field samples:

- **Sample preparation:** Cast test specimens (150×150×150mm cubes) using same material, water ratio,
- **Tests performed:**
  - Bulk density (per ASTM C20)
  - Cold crushing strength at 110°C × 24h (per ASTM C133)
  - Hot MOR at service temperature (per ASTM C583)
  - Permanent linear change after firing (per ASTM C210)
- **Acceptance criteria:** Properties must meet or exceed supplier TDS values within specified tolerances

Installation Success Criteria

Successful LCC installation requires discipline in five areas: (1) Precise water control within ±0.3% of volume, (2) Proper mixing using forced-action equipment for minimum 4 minutes total time, (3) Con vibration — stopping when air bubbles cease, not when surface is mirror-smooth, (4) Adequate curi retention, and (5) Rigorous adherence to controlled dry-out schedule, never exceeding 10°C/hour be pressure. Field data proves that installations following these procedures achieve 95–105% of labora

with shortcuts (excessive water for "workability," drum mixer use, rushed dry-out) achieve only 60–7
difference between 25-month and 15-month campaign life is almost always installation discipline, no

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FREQUENTLY ASKED QUESTIONS

LCC Installation FAQ

How critical is water addition accuracy for LCC castable? +

Can I use a drum mixer for LCC castable? +

How long can I work with mixed castable before it stiffens? +

What happens if I skip the controlled dry-out and heat up quickly? +

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