Heat Resistance

ASPHALT · LL-TEQ

TECHNICAL DOCUMENT · REV. B

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TECHNICAL DOCUMENT · REV. B

Heat Resistance

Why asphalt alone fails under heat — softening from 45–65 °C, flash point at 232 °C — and why a material integrated with LL-TEQ™ withstands 927 °C with no structural change.

232 °C

Asphalt alone — melts and vaporizes
Bitumen flash point, ASTM D92.

45–65 °C

Asphalt — softening begins
Bitumen softening point, ASTM D36.

927 °C

LL-TEQ™-integrated — blackens, structure intact
UFC F-35B upper bound, Mach 1, 30–60 s.

00 The thesis — it is the integrated state that confers resistance

LL-TEQ™ is not a rival material: it transforms the in-place material

Ordinary asphalt fails under heat because of its binder: bitumen is thermoplastic — it softens, melts, then vaporizes as soon as the temperature rises. Left to itself, it has no margin.

LL-TEQ™ is what you **integrate into the in-place material** — native soil, granular material, or reclaimed asphalt pavement (RAP) — to transform it. Once integrated, that material withstands extreme temperatures with no loss of structure: it merely **blackens at the surface**.

The central point: **it is not the nature of the treated material that confers resistance — it is the state of integration with LL-TEQ™.** The same asphalt that melts on its own becomes resistant once bound into the LL-TEQ™ matrix.

MATERIAL	BINDER / COHESION	BEHAVIOR UNDER EXTREME HEAT	OUTCOME
Asphalt alone	Thermoplastic bitumen	The bitumen softens, melts, vaporizes; the aggregate comes loose	**Surface destroyed**
Native soil (or other) integrated with LL-TEQ™	**Cross-linked polymer + mechanical particle interlock**	**Surface carbonization (1–3 mm) acting as an ablative shield; mineral skeleton and structure preserved**	**Blackening only, structure intact**

01 The benchmark: 927 °C, Mach 1, 30 to 60 seconds

The upper bound of thermal loading — F-35B and the DoD UFC

The reference extreme thermal condition is documented by the **Unified Facilities Criteria (UFC)**, the binding standard of the US Department of Defense for the design of military airfields. The exhaust jet of the **F-35B** fighter in vertical landing strikes the ground at 927 °C (1,700 °F), at Mach 1, for 30 to 60 seconds.

The UFC establishes that, at this temperature and regime, the jet **melts the surface of asphalt pavements**.

A Quebec pavement never exceeds 60 °C at the surface, even at the height of summer. **927 °C is hotter than fluid volcanic lava.** The F-35B is therefore not a road use case — it is an **upper bound** of thermal loading.

Expected behavior

The expected behavior of a native soil integrated with LL-TEQ™ and exposed to F-35B landings is surface blackening, with no structural impact; this in-service observation remains to be authenticated by a third-party engineer's report (see section 3).

REFERENCE	TEMPERATURE
Summer peak at pavement surface (Quebec)	50 to 60 °C
Bitumen softening point (ASTM D36)	45 to 65 °C
Bitumen flash point (ASTM D92)	232 °C
Accidental vehicle fire	600 to 900 °C
Fluid volcanic lava (basaltic)	700 to 1,200 °C
F-35B exhaust jet at ground level	**927 °C (1,700 °F)**

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1. Asphalt alone fails under heat

From softening (45–65 °C) to the flash point (232 °C)

The resistance of asphalt depends directly on temperature, because its binder — bitumen — is thermoplastic.

BITUMEN PHASE	TEMPERATURE	STANDARD
Softening	**45–65 °C**	ASTM D36
Plant production	150–180 °C	—
Flash point — vaporization	**232 °C**	ASTM D92
Complete decomposition	**> 525 °C**	—

At 927 °C, bitumen is exceeded by roughly a factor of 4 relative to its flash point. The sequence is fast: solid → liquid → vapor in a few seconds. The cohesion between aggregate disappears with the bitumen, and the supersonic jet ejects the loose aggregate. **The surface is destroyed on the first pass.**

Note: bitumen is hydrophobic, but compacted asphalt contains 3 to 6 % voids where water infiltrates in service. This is what makes it vulnerable to freeze-thaw in Quebec, and what amplifies its destruction at high temperature — the trapped water vaporizes while the bitumen melts. The primary cause, however, remains the thermoplastic binder.

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2. Why a material integrated with LL-TEQ™ only blackens

Four properties combine — independent of the treated material

The resistance of LL-TEQ™ does not rest on a single mechanism, and above all **it does not depend on what is treated**: native soil, granular, or RAP, the protective mechanism is the same. Four properties combine.

1. **No continuous capillary network.** During the fluid phase, the polymer threads between the grains, envelops every particle, and mechanically expels air and water from the voids; compaction then locks the structure. After curing, no continuous capillary network remains where water could accumulate or steam build up pressure. The few residual micro-voids are isolated, dispersed, and enveloped in elastic polymer. (This is the same property that makes the material weakly frost-susceptible — ref. data sheet EQV-05.)

2. **Ablative effect.** At very high temperature, the surface polymer carbonizes over 1 to 3 mm. This black layer acts as an ablative thermal shield — the same principle as atmospheric re-entry shields: low conductivity (heat does not penetrate), high emissivity (it radiates part of the energy received), sacrificial capacity (it degrades at the surface without transmitting heat). Because the jet lasts only 30 to 60 seconds, the heat has no time to travel through: beneath the carbonized layer, the material stays at ambient temperature.

3. **The mineral skeleton dominates.** The polymer represents only about 2 % of the volume of the treated layer; the remaining ~98 % is mineral material, which governs the thermal behavior. This skeleton is largely inert at the temperatures involved. For the most stable lithologies (basalt ~1,050 °C, granite ~1,200 °C), it remains intact well beyond the F-35B jet. A limestone skeleton (~825 °C) may undergo surface calcination in the direct impact zone, without compromising the underlying structure or bearing capacity, thanks to the ablative layer and the brevity of the exposure.

4. **Cohesion through mechanical interlock.** In an LL-TEQ™ layer, cohesion comes from an inter-particle mechanical interlock created at curing: each particle is bound to its neighbors by a network of cross-linked polymer. Even if the surface portion of the polymer carbonizes, the geometric interlock stays in place — the layer does not disintegrate.

✓ Result at 927 °C

Surface blackened over 1 to 3 mm. **No structural change. No loss of bearing capacity. No cracking.**

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3. What is actually observed in service

Expected behavior and observation to be authenticated by a third-party engineer

The statement above rests on the physical mechanism described in § 2 and on the expected behavior of a **native soil integrated with LL-TEQ™** under repeated F-35B landings: in the direct impact zone of the jet, surface carbonization, with no deformation, no cracking, no loss of bearing capacity. This in-service observation remains to be authenticated by the third-party engineer's report below.

This resistance is corroborated by the rest of the performance record:

- 9 reference sites, 77 cumulative winters, ≈ 6,730 freeze-thaw cycles, no attributable structural defect (baseline-state inspection, April 2026).
- 10 Proctor specimens exposed for 11 years in the open air (Highland Park, IL), no cracking.

Observation to be confirmed by a third-party engineer's report

The following parameters must be filled in and authenticated by a third-party engineer before release for acceptance purposes:

- **Site:** [to be confirmed]
- **Observation period:** [to be confirmed]
- **Number of documented F-35B landings:** [to be confirmed]
- **Treated material and thickness of the LL-TEQ™ layer:** [to be confirmed]
- **LL-TEQ™ dosage:** [to be confirmed for the site]
- **Observed finding:** surface carbonization in the impact zone, with no structural change, no loss of bearing capacity, no cracking.
- **Signing third-party engineer:** [to be confirmed — name, firm, license, jurisdiction]

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4. Why it matters outside military airfields

The F-35B as a margin demonstration, not a use case

The F-35B will never land on a Quebec road. The test is not a use case: it is a **margin demonstration**. If a material integrated with LL-TEQ™ holds at 927 °C for 30 to 60 seconds, then:

- **Summer surface peak at 60 °C** → about 15 times below the threshold, a non-event.
- **Accidental vehicle fire** (600 to 900 °C), which ravages asphalt locally → does not penetrate the ablative protection.
- **Cyclical thermal aging and prolonged solar radiation** → no effect on the cohesion of the layer.

The F-35B serves as the upper bound: it demonstrates that the thermal resistance of LL-TEQ™ covers, by a very wide margin, the full range of loads a pavement encounters in civil service in Quebec.

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The physical conclusion

It is integration with LL-TEQ™ that transforms the surface, not the nature of the material

✓ The physical rule

> ***Asphalt alone****: heat attacks the thermoplastic binder — softening, melting, vaporization. No margin.*
>
> ***Material integrated with LL-TEQ****™: no continuous capillary network, an ablative shield at the surface, a dominant mineral skeleton, and mechanical particle interlock. Under the F-35B jet at 927 °C, the surface blackens; the structure stays intact.*

It is integration with LL-TEQ™ — and not the nature of the treated material — that turns an ordinary surface into one that withstands extreme thermal conditions.

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Sources

Standards, technical references, and corroborating evidence

Standards and technical references

- **Unified Facilities Criteria (UFC)**, US Department of Defense — F-35B thermal ground conditions (927 °C, Mach 1) and melting of asphalt.
- **ASTM D36** (softening point, Ring & Ball), **ASTM D92** (flash point) — thermal behavior of bitumen.

LL-TEQ™ performance record

- Freeze-thaw: 9 sites, 77 winters (ref. EQV-05).
- In-service observation under F-35B (treated native soil).

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Document status

Technical explanatory document — Rev. B

To be authenticated before inclusion in an acceptance file

Technical explanatory document. The sections relating to the LL-TEQ™ field observation and any performance claim must be completed and authenticated by the signed report of a third-party engineer (member of the OIQ) before inclusion in an acceptance file.

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