



ENGINEERING SPECIFICATION • REVISION 3

Geofoam — EPS Lightweight Structural Fill

Moulded closed-cell EPS block, 12–30 kg/m³, placed dry as engineered lightweight fill so the weight of an embankment or backfill is designed out instead of the ground being improved.

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geofoam

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Issued for use

SECTION 31 23 23.33 — GEOFOAM (EPS BLOCK) LIGHTWEIGHT FILL

To the specifier. This Section is written to **ASTM D6817 TYPE designations**, not to trade grade names. You specify the **type** — EPS12, EPS15, EPS19, EPS22, EPS29, EPS39 or EPS46 — and the manufacturer supplies block meeting every minimum of that type. Insert your type at Clause 2.2.

Text in **[SCHEDULE: ...]** is a decision for the project engineer. It is not a gap. A product specification that fixed the flotation factor of safety, the slab design or the levelling course would be usurping the designer, and this one will not.

Text in **[CONFIRM: ...]** is a figure to be confirmed with the manufacturer for the supply.

PART 1 — GENERAL

1.1 SUMMARY

- A.** This Section specifies moulded expanded-polystyrene (EPS) geofoam block supplied as engineered ultra-lightweight structural fill, placed dry, without compaction, and covered by a permanent load-distribution slab.
- B.** The work includes the geofoam block, the impermeable membrane, the geotextile separation layer, the levelling course, the construction-stage hold-down, and the placing, cutting, restraint, protection and recording of the fill.
- C. The design of the works is not in this Section.** Geofoam is a material. The embankment, the foundation, the slab and every stability check are the project engineer's.

1.2 RELATED SECTIONS

Earthworks and subgrade preparation · Cast-in-place concrete (load-distribution slab) · Geosynthetics · Sub-base and surfacing · Waterproofing membranes · Dewatering.

1.3 REFERENCE STANDARDS

STANDARD	WHAT IT GOVERNS
ASTM D6817	Rigid Cellular Polystyrene Geofoam — <i>the type designations and their minimum properties</i>
ASTM D7180	Use of EPS Geofoam in Geotechnical Projects — <i>the design method</i>
ASTM D7557	Sampling of Expanded Polystyrene Geofoam Specimens
ASTM D1621	Compressive Properties of Rigid Cellular Plastics
ASTM D1622	Apparent Density of Rigid Cellular Plastics
ASTM C203	Breaking Load and Flexural Properties of Block-Type Thermal Insulation
ASTM D2863	Oxygen Index of plastics (the flame-retardancy criterion in D6817 Table 1)
SANS 10400-T	Fire protection (for the works generally)

There is no SANS standard for geofoam and no Agrément South Africa certificate for geofoam. Any document implying either is wrong.

1.4 DEFINITIONS

A. The two compressive figures — misreading this is the single most expensive error in geofoam design.

- 1. Compressive resistance at 1% strain.** The elastic limit. **This is the design value.** The sustained (permanent, long-term) compressive stress arriving at the top of the block shall not exceed it.
- 2. Compressive resistance at 10% strain.** A **failure-region** strength, measured well past yield. Across every ASTM type in Table 1 it is **approximately 2.7 times** the 1% figure. **It is NEVER a design load. It shall not be used to size the fill and it shall not appear in any load take-down.**
- Where a submitted datasheet quotes only a 10%-strain figure, the product **shall be rejected** as not demonstrating compliance with this Section.

B. Lot. (*Defined because the whole acceptance regime turns on it and, undefined, it is the clause most likely to end in adjudication.*) A **lot** is **one continuous moulding run of one ASTM type, uniquely identified by a batch reference, not exceeding [SCHEDULE: maximum lot volume, recommended 100 m³].** The batch reference shall identify the lot on every block face and on every delivery note. Rejection and acceptance under Clause 1.7 operate on the **lot**.

C. Type qualification is evidence, once per type per manufacturer, that the product meets **every** minimum of ASTM D6817 Table 1. **Lot acceptance** is evidence, for each lot delivered, that the block actually supplied meets the density and compressive minimums of the specified type. They are different things and this Section requires both.

1.5 DESIGN CRITERIA AND DESIGN RESPONSIBILITY

A. The project engineer shall carry out, record and sign off the following checks to ASTM D7180. They are design, not supply, and no manufacturer's data can perform them.

- 1. Sustained-load check.** Sustained stress at the top of the block $\leq$ the specified type's compressive resistance at **1% strain**, adjusted for service temperature under A.5.
- 2. Flotation check.** *Geofoam floats. Near water this, and not bearing, governs the design.*

Σ permanent dead load $\geq$ FS $\times$ buoyant uplift

buoyant uplift = $\gamma_w \times$ (submerged volume), where γ_w is the unit weight of the site groundwater — **9.81 kN/m³ for fresh water; take ~10.05 kN/m³ for saline or silt-laden water. [SCHEDULE: γ_w for the site.]**

- **Only PERMANENT dead load may resist uplift** — the slab, the pavement or cover, and the self-weight of block above the water line. **Traffic, live load and temporary surcharge shall NOT be counted as resisting.**
- **The self-weight of submerged block shall be counted once and once only.** Do not deduct it from the uplift *and* add it to the resistance.
- **Barbed connector plates shall NOT be counted in the permanent flotation resistance** unless their pull-out capacity from the EPS has been tested. They pull out of the foam long before the steel is stressed.
- The check shall be made for **three cases: [SCHEDULE: factor of safety against flotation — permanent case, flood case, and construction-stage case.]**
- **The construction-stage case is the one that is forgotten and it is usually the worst:** the fill is placed, the excavation can fill with water, and nothing is holding it down. It is designed under A.6, not left to the crew.

3. Sliding check — at EVERY interface, not just the block joint.

Sliding shall be checked at **every interface in the built section:** block-to-block, block-to-geotextile, geotextile-to-levelling-course, block (or membrane) to load-distribution slab, and — where a membrane is provided under Clause 2.5 — block-to-geomembrane and geomembrane-to-geotextile.

The governing plane is frequently the geomembrane, not the block joint. A smooth membrane is by construction a low-friction surface, and this Section requires a geotextile beneath the block on every job and a slab above it on every job

- so **every fill built to this Section has at least one non-EPS interface that the EPS-on-EPS figure does not describe.**
- Interface friction for **moulded and cut EPS faces against each other** is approximately $\mu \approx 0.5$. **This figure is indicative and applies to EPS-on-EPS only. Interface friction at every interface, EPS and non-EPS, shall be established by interface shear test. [SCHEDULE: design μ at each interface.]**
- The check shall be made under **all design horizontal actions**, including **traffic braking, lateral earth and water pressure, and seismic acceleration**. The low mass of the fill reduces seismic inertia; **it does not remove the inter-layer sliding check.**
- 4. Settlement check**, including the **elastic compression of the block** under the applied load, and the **long-term creep strain** over the design life. **[SCHEDULE: maximum permitted total strain (immediate + creep) over the design life.] The elastic modulus and the creep basis for the specified type shall be confirmed with the manufacturer, and where the design is sensitive to either, established by project-specific test on the delivered block.**
 - 5. Service-temperature adjustment.** The compressive values in Table 1 are determined at laboratory temperature. **Where the sustained temperature at the top of the block exceeds it, the compressive resistance and the creep allowance shall be adjusted for the design service temperature.** Under a dark pavement in a South African summer, the top of the fill runs well above laboratory temperature. **[SCHEDULE: design temperature at the top of the block, and the minimum cover required to achieve it.]**
 - 6. Construction-stage hold-down.** The engineer shall **design** the temporary restraint against flotation and wind for the whole period between the first block and the cured slab, to the construction-case factor of safety scheduled at A.2, and **show it on the drawings**. It is submitted under 1.6 and it is a hold point under 3.1.
 - 7. Submerged unit weight.** Where any part of the fill can be submerged, the **load take-down and the settlement check shall use the long-term moisture-absorbed unit weight** of the block, and the **flotation check shall use the dry unit weight**. Absorbed water adds mass to a material whose whole purpose is that it has none — ignoring it is unconservative in exactly the application (a compensating, load-balancing fill) where the material is most often chosen.

B. Scheduled items. The following are the project engineer's and shall be shown on the drawings:

[SCHEDULE]	Load-distribution slab: thickness, concrete grade, reinforcement, separation layer
[SCHEDULE]	Levelling course: material grading and layer thickness
[SCHEDULE]	Permanent anti-flotation measures: ballast thickness and unit weight, or anchor type, capacity and spacing
[SCHEDULE]	Construction-stage hold-down: material, quantity, arrangement, factor of safety
[SCHEDULE]	Connector-plate requirement, type, capacity and spacing, where used
[SCHEDULE]	Transition detail: stepping of the geofoam into adjacent conventional fill
[SCHEDULE]	Penetration details, and standoff and sleeving of any hot service
[SCHEDULE]	Fire separation distance for the stockpile and the cutting area

1.6 SUBMITTALS

A. Before the order is placed:

- 1. The engineer's design statement:** the sustained design stress in kPa, the ASTM type selected against it, the flotation factor of safety adopted for each of the three cases, the sliding check at each interface, and the settlement and creep allowance. *Nothing ties the type supplied to a stated stress unless this exists.*

2. **Type-qualification evidence** for the specified type: a report demonstrating **every** minimum of ASTM D6817 Table 1 — density, compressive resistance at 1%, 5% and 10% strain, flexural strength, and oxygen index.

3. The **construction-stage hold-down design** (1.5.A.6).

B. Before delivery:

1. Manufacturer's declaration that the block supplied meets **every minimum** of the specified ASTM D6817 type, and that it is **flame-retardant (FR) grade**.

2. The **nominal moulding density** proposed, with confirmation that **95% of that nominal is greater than or equal to the type's minimum density**. (*ASTM densities are MINIMUMS, not nominals. The declared manufacturing tolerance is minimum density = 95% of nominal; that is the arithmetic which governs.*)

3. **Minimum age from moulding to delivery**, declared on the delivery note. (*Green block still carries blowing agent and moulding moisture: it shrinks after placement, its measured properties drift, and its stockpile fire behaviour is worse than that of aged block.*) **[SCHEDULE: minimum age from moulding, in days.]**

4. Block schedule: dimensions, type and FR marking, batch reference, block count.

5. Membrane and geotextile product data, **with the EPS-compatibility confirmation required by 2.5.C**.

6. The setting-out drawing: course layout, joint stagger, cut blocks, transitions, penetrations.

C. With each delivery: a delivery note showing the ASTM **type**, the **FR identification**, the **batch reference**, the **moulding date** and the block count.

D. Before any block of a lot is placed: the **lot acceptance test certificates** required by 1.7. *This is a hold point. See 3.1.*

1.7 QUALITY ASSURANCE — ACCEPTANCE RESTS ON TESTING THE BLOCK THAT ARRIVES

This is the load-bearing clause of this Section.

Conformance with the specified ASTM D6817 type is demonstrated by TESTING THE BLOCK DELIVERED TO SITE — not by a datasheet. On any load-bearing fill this is not optional, and it should be demanded of every supplier without exception. A datasheet describes what a manufacturer intends to mould. The lot test describes what arrived on your job.

A. The testing laboratory shall be independent of the manufacturer and of the Contractor, and accredited (SANAS or equivalent) for the test methods used. *Without this, the manufacturer whose catalogue figures this Section refuses to accept as evidence may perform the acceptance test on its own product and issue its own certificate. That would collapse the one mechanism the Section is built on.* **[SCHEDULE: who appoints the laboratory — the Employer / the project engineer.] [SCHEDULE: who bears the cost of sampling, testing and the sacrificial sample blocks.]**

B. Sampling to ASTM D7557. Sampling shall be **witnessed by the engineer or his representative**; each specimen shall be **traceable to a marked block and its batch reference**; and **retained specimens shall be held until the fill is accepted**.

C. Lot acceptance testing. For each lot:

1. **Apparent density** — ASTM D1622.

2. **Compressive resistance at 1%, 5% and 10% strain** — ASTM D1621. (*All three. D6817 defines the type on all three, and a minimum that is never tested is not a requirement.*)

3. Specimens shall be **conditioned as the test method requires**, and the report shall state the conditioning.

D. Acceptance. Every tested specimen shall meet or exceed **the minimum density and all three compressive minimums** of the specified type. **Flexural strength and oxygen index are demonstrated once by the type-qualification evidence of 1.6.A.2**, not lot by lot.

- E. Frequency.** *Recommended default; the specifier may edit it.* **[SCHEDULE: one sample per 100 m³ delivered, or one per lot, whichever is the more frequent; minimum three samples per project. Increase to one per 50 m³ where the sustained stress exceeds 75% of the specified type's 1%-strain resistance.]**
- F. Hold point.** *No block of a lot shall be placed in the permanent works until that lot's acceptance results are on file and meet C. This is deliberate and it is the most important sequencing rule in the document. If the fill may be built before the results arrive, then a failure is discovered under a closed membrane and a reinforced slab — and the commercially realistic outcome is not that the fill is dismantled. It is that the failure is argued away and the fill stays. This Section is not going to make that the likely outcome.* **[SCHEDULE: laboratory turnaround, in working days from sampling. The Contractor's programme shall show the sampling-to-result period as a fixed activity.]** Where the programme cannot carry the turnaround, **require a pre-delivery lot test at the works, sampled by the independent laboratory.**
- G. On a failing specimen — the sequence, in order:**
- 1. One re-test** is permitted, on **[SCHEDULE: number]** further specimens from the **same lot**, to the same acceptance criterion.
 - 2. On failure of the re-test, the LOT is rejected** and shall be removed from site. **A failing lot shall not be accepted on the strength of a datasheet.**
 - 3. Cost.** The manufacturer bears the cost of **replacing the non-conforming block and of the re-test**. Because F prohibits placing untested block, **the cost of removing and reinstating already-placed fill is not the manufacturer's where placement took place before the results were on file** — that placement was in breach of F. **[SCHEDULE: allocation of any remaining cost and of delay.]**
- H. Manufacturing quality system.** The manufacturer shall operate a **certified ISO 9001 quality management system whose scope covers the manufacture of EPS block**, and shall submit the certificate with the type-qualification evidence.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Marking.** Every block shall be marked on the block face with the **ASTM type**, the **FR identification** and the **batch reference**. **Blocks not identified as FR grade shall be rejected at the gate.**
- B. Fire on site.** Geofoam is a **concentrated combustible load**, and this Section requires a **heat-cutting process** at the face of it (3.7). The regime is therefore not optional:
- 1. A designated storage area** at the scheduled fire separation distance from ignition sources, hot works, hydrocarbons and any hot-work area. **[SCHEDULE: separation distance, per the site fire plan.]**
 - 2. No smoking** and **no hot work** within the separation distance. Signage to that effect.
 - 3. Class A extinguishers at the stockpile and at the working face.**
 - 4. A designated hot-wire cutting area** away from the stockpile, with an extinguisher to hand.
 - 5. Offcuts and packaging bagged and removed daily.** Loose offcuts are both a fire-spread path and, in the drains, a flotation risk.
- C. The stockpile and the placed fill shall be ballasted or restrained at the end of every working day, without exception.** At the densities of Table 1 an uncovered fill has almost no self-weight and **it blows away**. A fill left unrestrained over a weekend is a fill that will be collected out of the surrounding properties on Monday. *This clause is not advice. It is a requirement, and the restraint is designed under 1.5.A.6, not improvised on a Friday afternoon.*
- D. Protect from prolonged UV.** Protect the arrises: the block is stiff and brittle.

1.9 SITE CONDITIONS AND ENVIRONMENTAL LIMITATIONS

- A. Sustained service temperature shall not exceed 70 °C.** *(A range is not a limit, and an ambiguity in our own document is construed against us. Published EPS softening data spans roughly 70–80 °C; 70 °C is specified, and it is the conservative end.)* Note that the **creep rate rises with temperature well below any softening point** — see 1.5.A.5.
- B. Hot services.** Any steam line, hot-process pipe or flue passing through or beside the fill shall be **sleeved or boxed in a mineral material** to a scheduled standoff. **[SCHEDULE: standoff and sleeving detail.]**
- C. Hot-applied bitumen shall never contact the geofoam.** It goes onto the base course, **above** the load-distribution slab.
- D. Hydrocarbons, including vapour and contaminated ground.** Before the membrane of Clause 2.5 may be omitted, the engineer shall issue a **written statement, based on the ground investigation**, that petroleum exposure can be reliably excluded. It shall address:
- 1. Contamination of the in-situ ground and of the imported levelling-course and backfill material** — screened, not assumed.
 - 2. Hydrocarbon vapour**, which attacks EPS without any liquid ever reaching it.
 - 3. Migration from outside the works** — an adjacent forecourt, a leaking buried fuel line, an oil-filled cable duct.

Where the exposure cannot be reliably excluded by a membrane, **geofoam shall not be used** and a mineral lightweight fill shall be substituted.

- E. Burrowing fauna.** Where the ground investigation, the region or the adjoining works indicate **termite or rodent activity**, the fill shall be protected by a **continuous physical barrier at all faces and penetrations**, or by a treated perimeter to the engineer's detail. A continuous, detailed geomembrane envelope may serve this function. **The exposed faces of the fill shall be sealed before covering.** *Galleries and nests in the block are a slow, silent loss of bearing area under a slab whose whole job is to keep the peak stress below σ_1 %. The failure signature is the same as dissolution: a buried void, nothing to read at the surface, then a local drop.*

1.10 WARRANTY

- A. What is warranted.** Technopol SA (Pty) Ltd warrants that the **block as supplied** conforms to the specified ASTM D6817 type, to the stated dimensions, and is free of manufacturing defect, for **ten (10) years from the date of delivery**. Where Technopol or its approved specialist places the fill, the **placement is warranted for five (5) years** from practical completion.
- B. To whom.** The warranty is given to the **party who purchased the block from Technopol** and, where assigned in writing by that party, to the **Employer**.
- C. What is NOT warranted, because it is design and not manufacture:** **creep** under a sustained stress the designer selected; **flotation**, because EPS floats and buoyancy is a design case; **dissolution**, because EPS is dissolved by hydrocarbons and their exclusion is a detailing decision; and any block **placed in breach of Clause 1.7.F** (placed before its lot acceptance results were on file).
- D. Sole remedy.** Technopol's liability under this warranty is limited, at Technopol's election, to **replacement of the non-conforming block or refund of its purchase price**. Technopol excludes liability for indirect, consequential and pure economic loss, **including the cost of removing, replacing or reinstating any works over or around the block** — save as stated in E.
- E. What cannot be excluded, and is not.** **Nothing in this Section excludes or limits any liability which cannot lawfully be excluded or limited, including liability under sections 55, 56 and 61 of the Consumer Protection Act 68 of 2008.**
- F. Notice.** A claim shall be notified in writing to Technopol within **[SCHEDULE: notice period]** of the defect becoming apparent, and Technopol shall be given access to inspect before remedial work.

G. This warranty is given on Technopol's conditions of sale, which prevail over this Section. **This Section is Technopol's document only in its unedited form.**

1.11 PRE-INSTALLATION MEETING

Before the first delivery, the **project engineer, the geotechnical engineer, the Contractor and the manufacturer** shall meet to confirm: the design statement of 1.6.A.1; the lot definition and the test regime; the hold point of 1.7.F and the laboratory turnaround; the construction-stage hold-down; the sequence of placement, covering and slab casting; and the fire regime.

PART 2 — PRODUCTS

2.1 MANUFACTURER AND SUBSTITUTION

A. Technopol SA (Pty) Ltd, 9 Wright Road, Nuffield, Springs, Gauteng.

B. Approved equal. A substituted manufacturer shall demonstrate **all** of the following. *(The substitution gate is not wider than the gate the specified product passes.)*

1. Production to **ASTM D6817**, with type-qualification evidence per 1.6.A.2.
2. A certified **ISO 9001** quality management system whose scope covers EPS block (1.7.H).
3. **Flame-retardant grade**, meeting the **minimum oxygen index of the specified ASTM D6817 type** (24.0 volume %, Table 1), evidenced by the type qualification of 1.6.A.2.
4. **Block marking** per 1.8.A.
5. Acceptance of the **Clause 1.7 testing regime in full**, including the independent accredited laboratory and the hold point.

2.2 GEOFOAM TYPE — SPECIFIED TO ASTM D6817

A. The geofoam shall be [SCHEDULE: INSERT ASTM TYPE — e.g. EPS19] to ASTM D6817, FLAME-RETARDANT (FR) GRADE.

B. FR grade shall be stated on the order, on every delivery note and on every block (1.8.A). Blocks not identified as FR shall be rejected. *This is not a formality, and it is not a fire-classification claim: **ASTM D6817 Table 1 sets a minimum oxygen index of 24.0 volume % for every type**, and the oxygen index is what flame-retardant grade delivers. A block that does not meet it **is not the type**, whatever its density. The requirement comes from the standard the block is specified to — see 2.4.E.*

C. ASTM D6817 Table 1 — the minimums that define each type. **EVERY VALUE IS A MINIMUM.**

TYPE	DENSITY, MIN. (KG/M ³)	COMPRESSIVE RESISTANCE, MIN. (KPA) @ 1%	@ 5%	@ 10%	FLEXURAL STRENGTH, MIN. (KPA)	OXYGEN INDEX, MIN. (VOL %)
EPS12	11.2	15	35	40	69	24.0
EPS15	14.4	25	55	70	172	24.0
EPS19	18.4	40	90	110	207	24.0
EPS22	21.6	50	115	135	276	24.0
EPS29	28.8	75	170	200	345	24.0
EPS39	38.4	103	241	276	414	24.0
EPS46	45.7	128	300	345	517	24.0

Per ASTM D6817: where yield occurs before 10% deformation, the compressive resistance and deformation at yield shall be reported in addition to the 1%, 5% and 10% values. Where the product has an external skin, testing is undertaken with the skin intact.

D. The @1% column is the design value (Clause 1.4.A). The @10% column is a failure-region strength and shall not be used to size the fill.

E. The density figures are MINIMUM densities, not nominal. The manufacturer shall set the nominal moulding density so that **the minimum density (95% of nominal) meets or exceeds the type minimum**, and shall declare the nominal under 1.6.B.2.

F. Availability. Confirm the specified type with the manufacturer before it goes into the contract.

G. Compliance is demonstrated by **type qualification and lot testing** under Clause 1.7, **not** by a datasheet.

2.3 PHYSICAL PROPERTIES

PROPERTY	VALUE	
Buoyant uplift, submerged	$\gamma_w \times \text{submerged volume}$; net uplift = ($\gamma_w - \gamma_{\text{block}}$). Approximately 9.36 to 9.70 kN/m³ across Table 1 in fresh water	calculated
Interface friction coefficient μ , EPS on EPS only	≈ 0.5	° not tested
Thermal conductivity λ @ 10 °C	0.035 W/m·K. λ is density-dependent ; across the type ladder it ranges 0.033–0.045 W/m·K	°
Water absorption	[CONFIRM: value, with its unit (by volume or by mass), test method and immersion period.] A figure without its unit is unusable: 4% by mass on a 20 kg/m ³ block is trivial; 4% by volume triples the unit weight of the fill.	°
Dimensional stability, 7 days at 80 °C	$\leq 1.0\%$	°
Typical block	2550 × 1250 × 960 mm; other sizes cut to order	—
Dimensional and squareness tolerance	[SCHEDULE: to be stated in the contract.]	—

° **Declared value.** Where a figure is load-bearing in the design, it shall be established by test on the block supplied.

2.4 FIRE — WHAT ACTUALLY APPLIES TO A BURIED FILL

- A. All EPS is combustible.** Flame-retardant treatment changes ignition and flame spread. **It does not make EPS non-combustible, and no treatment ever will.**
- B. No reaction-to-fire class is claimed for geofoam, and none is needed.** A reaction-to-fire classification describes how a product's **exposed surface** behaves in a room. **Geofoam is buried.** In the permanent works it is **permanently covered** by the load-distribution slab, pavement or soil (Clause 3.10.E), so it has **no exposed surface and no reaction-to-fire scenario in service.** *Anyone offering you a Euroclass rating as a reason to choose one buried fill over another is answering a question this application does not ask.*
- C. There is no fire-resistance (REI) rating for geofoam and there never will be** — an REI is a property of a tested assembly, not of a fill material.
- D. The fire exposure that IS real is on site, before the fill is covered** — a large, concentrated combustible stockpile, with a hot-wire cutting operation at the face of it. **That is a genuine hazard and it is specified in Clause 1.8.B and Clause 3.7.** It is not a paperwork exercise.
- E. The oxygen-index minimum of the specified ASTM D6817 type (24.0 volume %, Table 1) still applies** and is part of the type. That is a material property, established once by the type qualification of Clause 1.6.A.2 — it is not a reaction-to-fire classification and shall not be presented as one.

2.5 IMPERMEABLE MEMBRANE / HYDROCARBON BARRIER

- A. Where a petroleum, diesel, aromatic-solvent or hot-bitumen exposure is credible** — a fuel forecourt, a refinery, a tank farm, a workshop apron, an oil-filled cable trench, contaminated or made ground, or any pavement carrying such traffic — **a continuous impermeable geomembrane shall be laid beneath and around the entire fill and closed over the top.** Credibility is established under **1.9.D**, on the ground investigation — **not** on a judgement made at the cheapest moment in the project.
- B. Why this is absolute.** Petroleum products **dissolve** EPS. A single spill can vaporise a section of the fill. **The lost volume shows up as a sudden local collapse of the pavement above, with no prior warning and no distress to read.** There is no repair short of excavation.
- C. Compatibility — the trap in this clause.** The membrane, its seaming method, and every primer, adhesive, sealant, tape, mastic and protection layer used with it shall be demonstrably compatible with EPS. Solvent-borne primers and adhesives, and bituminous self-adhesive or torch-applied membranes, shall not be used in contact with the geofoam. The Contractor shall submit **written confirmation of EPS compatibility from the membrane supplier.**

The single most likely route by which a solvent reaches the block is the barrier installed to keep solvents away from it. A contractor will not read the ban on "spills" at 3.11 as covering the product the specification told him to install.

- D. [SCHEDULE: membrane material, thickness, seam method and seam test.]** *Technopol does not manufacture or supply the membrane and specifies no product.*
- E. Penetrations** shall be sealed with a **detailed, tested collar or boot.** An unsealed penetration defeats the envelope. A **protection layer** shall be provided where the membrane can be punctured, and the membrane shall be **inspected for puncture immediately before it is covered.**

2.6 GEOTEXTILE SEPARATION LAYER

Non-woven geotextile between the levelling course and the block, to keep fines and bedding sand out of the block joints. It shall be **compatible with EPS** on the same terms as 2.5.C. **[SCHEDULE: geotextile grade.]**

2.7 MECHANICAL INTERLOCK — BARBED CONNECTOR PLATES

- A.** Where called for by the engineer, barbed connector plates shall be laid between courses to resist sliding and construction-stage uplift: on slopes, under horizontal load (traffic braking, seismic), and on any exposed fill during

construction.

B. [SCHEDULE: plate type, capacity and spacing.]

C. Connector plates are not a substitute for ballast (1.8.C), and **shall not be counted in the permanent flotation resistance** unless their pull-out capacity from the EPS has been tested (1.5.A.2).

2.8 LOAD-DISTRIBUTION SLAB

A. A reinforced-concrete load-distribution slab shall be cast over the completed fill. **[SCHEDULE: thickness, concrete grade, reinforcement.]** *The slab is the project engineer's design.*

B. Reinforcement shall be supported on spreaders sized so that the bearing stress on the EPS remains within the specified type's compressive resistance at 1% strain. Bar chairs bearing directly on the block are not permitted.

C. A separation / slip layer shall be provided between the slab and the block to the engineer's detail — or the membrane shall be stated to serve as one. **Its friction bears directly on the sliding check at 1.5.A.3 and shall be consistent with it.**

2.9 CONSTRUCTION-STAGE HOLD-DOWN MATERIALS

Ballast, sandbags, netting, strapping or connector plates, as designed under 1.5.A.6. **[SCHEDULE: material, unit weight and quantity.]** The materials shall be **on site, in the designed quantity, before the first block is placed** (3.1).

2.10 GAP-PACKING MATERIAL

Cut EPS offcuts of the same type as the block. Soil, sand, spoil, aggregate, cementitious material and expanding foam shall NOT be used to pack a joint. See 3.5.

PART 3 — EXECUTION

3.1 EXAMINATION — HOLD POINTS

Placement shall not commence until **all** of the following are satisfied:

- 1. The subgrade has been trimmed and the levelling course proved** under 3.2. *The platform is the one thing that cannot be corrected afterwards.*
- 2. The lot acceptance results for the delivered lot are on file and meet 1.7.C** (the hold point of 1.7.F). **No block from an untested lot shall be laid.**
- 3. The engineer's design statement** (1.6.A.1) is on file.
- 4. The construction-stage hold-down materials are on site in the designed quantity** (2.9).
- 5. Dewatering is operating** and will be maintained under 3.3.

3.2 SUBGRADE PREPARATION AND LEVELLING COURSE

A. Trim the subgrade, or the structure top, to a **plane surface** at the design level.

B. Screed the levelling course and strike it off true. **[SCHEDULE: material grading and thickness.]** The imported material shall be **free of hydrocarbon contamination** (1.9.D.1).

C. Prove the plane with a straightedge before a single block is laid. A hollow under the straightedge is a hollow under the block: the block will bridge it and then break into it. **The block is stiff and brittle. It needs a plane, not a compacted surface.**

3.3 DRAINAGE AND DEWATERING

- A. Provide drainage so that water cannot accumulate against or beneath the fill. **Standing water is a flotation case.**
- B. **Dewatering shall be provided and MAINTAINED for the whole period between the first block and the cured slab.** This is the construction-stage flotation case, and it is the one that actually happens.
- C. **Keep drains clear of EPS offcuts** (1.8.B.5). A blocked drain is a flotation case.

3.4 SEPARATION LAYER AND MEMBRANE

Lay the geotextile onto the levelling course. Where Clause 2.5 applies, lay the geomembrane beneath and around the fill, continuous, with seams made and tested to the specification, all penetrations sealed to 2.5.E, and close it over the top of the fill before the slab is cast. **Inspect for puncture immediately before covering.**

3.5 BLOCK PLACEMENT

- A. **Lay the blocks DRY. Do not compact them. Do not wet them. Do not bed them in mortar or sand.**
- B. String the first course to the setting-out line and lay it with **tight butt joints**.
- C. **Offset the vertical joints of each course by at least half a block against the course below.**
- D. **Lay each course perpendicular to the one under it**, so the joints cross rather than stack.
- E. **A continuous vertical joint through the fill is a defect:** a path for water and fines, and a plane the fill can shear on.
- F. **Joints and gaps — the rule, in one place.** Joints shall be **butted tight**. A **residual gap not exceeding 10 mm** is acceptable **provided it is packed with cut EPS offcuts of the same type** (2.10). A gap **exceeding 10 mm** shall be re-cut or the block replaced. **SOIL, SAND, SPOIL, AGGREGATE, CEMENTITIOUS MATERIAL AND EXPANDING FOAM SHALL NOT BE USED TO PACK A JOINT.** *Sand in a joint puts back the mass the fill exists to remove, creates a water and fines path, and forms a hard incompressible inclusion between two compressible blocks. Once covered it is invisible for the life of the structure. If the crew is not told what to pack a gap with, it will use what is to hand — and what is to hand is bedding sand.* **[SCHEDULE: gap measurement method and the number of joints checked per course.]**

3.6 CONNECTOR PLATES

Where scheduled, lay to Clause 2.7.

3.7 FIELD CUTTING AND TRANSITIONS

- A. **Hot-wire cut** anything that must butt tight. Hand saw or chain saw for bulk trims. Complex profiles — battered abutment faces, transitions, penetrations — shall be **factory-cut to the setting-out drawing** wherever practicable.
- B. **Hot-wire cutting is a hot process on a combustible material.** It shall be carried out **in the designated cutting area** (1.8.B.4), at the scheduled separation distance from the stockpile, **under a hot-work permit, with a fire watch and extinguishers to hand**, and **all offcuts bagged and removed at the end of each shift**.

3.8 BUOYANCY, UPLIFT AND ANTI-FLOTATION

- A. Execute the permanent anti-flotation measures scheduled under 1.5.B.
- B. **Install the construction-stage hold-down as designed** (1.5.A.6) — not as improvised.
- C. **The fill shall be ballasted or restrained at the end of every working day** (1.8.C).
- D. **Where the fill will be below the design groundwater or flood level at any stage — including during construction — it shall not be left unballasted overnight.**
- E. **Sequence. Do not place more fill than can be promptly covered or restrained.** **[SCHEDULE: maximum area of fill left uncovered.]**

3.9 LOAD-DISTRIBUTION SLAB

- A. Cast the slab **before any plant, dumper or loaded vehicle runs over the fill.**
- B. **No plant shall track on bare blocks. Not once, not to save a movement.** Running a wheel on a bare block crushes it, there is no repair, and **the crushed block is a void under the finished pavement. A breach of this clause shall be reported under 3.13.D before the area is covered.**
- C. **The concrete operation is where the block actually gets crushed, and it is the operation the specification usually forgets.** The pre-cast activity routinely delivers far higher local stress to the bare block than the finished pavement ever will. Accordingly:
 - 1. Reinforcement on **spreaders**, not bar chairs (2.8.B).
 - 2. **No immersion vibrator, screed rail foot, pump line, barrow run or material stack shall bear on bare block.**
 - 3. The block face shall be **inspected for damage immediately before the pour**, by [SCHEDULE: who], and the inspection recorded.

3.10 BACKFILL, SIDE SUPPORT AND COVER

A dry-laid, near-weightless block stack has almost no normal stress on its joints, and therefore almost no frictional resistance to lateral shove. A roller or plate compactor working against the free face WILL move it — and once the courses are displaced, the joint stagger and the load path are gone, and the damage is buried.

- A. **No compaction plant shall operate on, or directly against, the geofoam. [SCHEDULE: standoff distance for compaction plant.]**
- B. **Placement of backfill against a wall, abutment or basement wall shall be BALANCED and SEQUENCED** so that no unbalanced lateral thrust is applied to the structure and the courses are not shoved.
- C. The block stack shall be **laterally restrained** during backfilling.
- D. **STEP the geofoam courses into the adjacent conventional fill** over the transition length shown on the drawings, so the stiffness step is distributed. *A vertical geofoam-to-soil face reads straight through the pavement above as a differential-settlement crack — the "bump at the end of the bridge".*
- E. Cover the fill permanently: slab, pavement or soil.

3.11 PROTECTION — HYDROCARBONS, HEAT, HOT WORKS AND UV

- A. **No petrol, diesel, solvent or hot-applied bitumen shall contact the geofoam, at any stage.** Hot-applied bitumen goes onto the base course, **above** the slab. **This includes solvent-borne membrane primers and bituminous membranes** — see 2.5.C.
- B. **No open flame, welding, burning or grinding over or adjacent to the fill.** ****Hot-wire cutting under 3.7 is permitted, and only under the controls stated there.**** *(The prohibition is drafted to be enforceable. A blanket ban that also forbade the cutting the Section requires would be waived wholesale on the first day, and the fire clause would lose its force on the one operation that actually matters.)*
- C. **Sustained service temperature shall not exceed 70 °C (1.9.A).** Hot services sleeved per 1.9.B.
- D. Protect from prolonged UV exposure.

3.12 TOLERANCES

Recommended defaults. The specifier may edit them; if he does not, these apply.

	DEFAULT
Top of completed fill, deviation from design level <i>(before the elastic-compression allowance of 1.5.A.4)</i>	± 25 mm
Deviation of the fill face from the setting-out line	± 25 mm
Residual joint gap — rejection threshold, not a target ; any gap is packed per 3.5.F	10 mm
Levelling course, under a 3 m straightedge	± 10 mm

3.13 FIELD QUALITY CONTROL, RECORDS AND NON-CONFORMANCE

Once the slab is cast the fill cannot be seen again. The record set is the only thing that will exist.

A. Records. Close out the QA file with:

1. Delivery notes: ASTM type, **FR identification**, batch reference, moulding date, block count.
2. **The lot sample references and the laboratory results** (1.7) — density and compressive resistance at 1%, 5% and 10% strain — **and the date each result was received, against the date its lot was placed** (the hold point of 1.7.F is auditable or it is nothing).
3. The **type-qualification evidence** (1.6.A.2).
4. **Photographs of the completed fill before covering.**
5. **Surveyed levels of the top of the fill, before and after the slab.** *This is the only way the elastic-compression allowance of 1.5.A.4 and the tolerance of 3.12 are ever verified.*
6. The **course-by-course as-built**: joint stagger, course rotation, connector-plate layout.
7. The **daily ballast / restraint record**.
8. The straightedge records for the levelling course.
9. Membrane seam tests, penetration seals, and the pre-cover puncture inspection, where 2.5 applies.

B. As-built and future excavation. Issue an **as-built showing the extent and depth of the geofoam and the membrane**, and install a **warning marker tape above the fill**. *The first third party to trench into the completed works will otherwise breach the hydrocarbon barrier with no way of knowing it is there.*

C. Non-conformance — report BEFORE covering. The following shall be reported to the engineer **immediately and before the affected area is covered**:

1. Plant that has run on bare block.
2. Any fuel, oil or solvent spill onto or near the fill.
3. Any hot product placed above the block.
4. Any wind or flotation displacement of a placed course.
5. Any crushed, damaged or contaminated block.

D. Remedy. The affected area shall be **exposed, assessed and reinstated. It shall not be covered.** *A prohibition with no reporting duty and no remedy is a prohibition that is complied with by saying nothing. The crew that ran a dumper across the fill has every incentive to cast over it. This clause is what says otherwise.*

END OF SECTION

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