

LOW SHRINK INDUSTRIAL FLOORS

SOLUTION GUIDE



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GLOSSARY

Dry Shrinkage

The result of concrete's internal pore structure collapsing due to the evaporation of water¹.

Slump Test

Test to measure the workability of fresh concrete. A conical mould (Abraham cone) is filled with concrete and removed; the height by which the concrete settles below its original height provides a measure of workability (in accordance with BS 12350-22).

Slump Flow Test

A modified version of the slump test, it measures the spread (slump flow) of a fluid concrete, in accordance with BS 12350-83.

Design Chemical Class (DC)

The level of resistance that a concrete offers to selected aggressive chemical environments, in accordance with BS 8500⁴.

Abrasion Resistance (AR)

The classification of resistance to abrasion of a concrete surface with respect to BS 8204⁵ providing a maximum depth of wear for corresponding specified classes.

Autogenous Shrinkage

Volume change that occurs without any moisture transfer as a result of internal chemical reactions⁶.



Our approach to construction encompasses innovative sustainable products, efficient building systems and practical solutions. We recognise the important role we have in promoting sustainable construction by optimising our products, their use and whole life performance. This document is one of a suite that identifies specific construction solutions that can help deliver a sustainable built environment. They explore the details of each system, its performance benefits, how it can be implemented in a project and then compares its environmental performance against alternative solutions.

This document introduces Topfloor Low Shrink, which contributes to creating buildings that are long lasting, robust and efficient.

Typical Applications

Building sectors: Warehouses, commercial buildings, factories, retail, industrial, waste.
For interior slabs.



INTRODUCTION

Topfloor creates slabs that are stronger and more durable with less shrinkage (both drying and hydration) and increased bay sizes to minimise joints, than those constructed with conventional concrete. Higher compressive and flexural strengths are developed enabling a reduction in slab thickness providing an improved environmental profile.

High quality finishes can be achieved through power floating with the option to colour and polish to enhance aesthetics.

Other advantages include

- Lower shrinkage characteristics
- Increased bay sizes
- Removal or reduction of steel
- Reduced joint maintenance
- High performance surface finish
- Reduced environmental footprint



Location: Scunthorpe

Client: SOMI Trailers Ltd

Year: 2006

Floor surface area: 1750m²

Slab depth: 150mm

Volume of Topfloor 260m³

Steel: None

“It was the right choice; compared to concrete in other projects Topfloor is way ahead in every respect. It is clear to me that if you are looking ahead to reduce costs both financial and environmental, then innovative products like Topfloor are key.”

Pauline Dawes
Managing Director, SOMI Trailers Ltd.

THE LOXLEY BUILDING, SCUNTHORPE

Construction of the Loxley Building saw the first commercial pour of Topfloor in the UK. Since completion the slab has been subjected to high trafficking loads from articulated HGVs and the associated infrastructure linked to HGV trailer construction and repair. Building occupiers SOMI Trailers have subsequently developed a new and innovative trailer solution increasing load capacity by 25%, without any detrimental effects experienced.

The original proposed solution for SOMI Trailers was a C40 slab with 40 kg/m³ of steel fibres. The Topfloor solution enabled slab depth to be reduced and steel reinforcement to be removed, whilst still meeting the design requirements. SOMI Trailers were able to realise substantial cost savings through material efficiency and they were able to employ a more sustainable solution.

Five years on... Following a prolonged period of use there have been no issues of cracking, flaking or dusting and the floor has not succumbed to any deleterious actions. The flooring solution has not sunk, deformed through impacts or absorbed any spills associated with heavy industrial use. The long standing issue of joint maintenance has also been diminished through not only a reduction in their number but also their susceptibility to deterioration.

VEOLIA MECHANICAL BIOLOGICAL TREATMENT (MBT) FACILITY, SOUTHWARK

The Southwark Mechanical Biological Treatment facility was Veolia's first inner city site of its kind. The facility handles 85,000 tonnes of waste per annum and due to the nature of this waste is subject to conditions that can cause severe and rapid degradation. The Topfloor solution provided the required levels of abrasion resistance and conformed to design chemical classes 2 and 4¹.

By adopting this solution it was demonstrated that the initial slab design depth could be reduced by 10% without affecting performance requirements. This

created an opportunity to save 360m³ the original depth of 200mm to provide a solution that offered greater levels of durability performance.



Location: Southwark

Client: Volker Fitzpatrick for Veolia

Year: 2010

Floor surface area: 18,000 m²

Volume of Topfloor: 3,500 m³



Shopping at ASDA Minworth

Location: Minworth

Client: RG Group for Asda

Year: 2009

Floor surface area: 11,500 m²

ASDA SUPERCENTRE, MINWORTH

The versatility of Topfloor as a solution for refurbishment and retrofit as well as new build was demonstrated in the refurbishment of one of Asda's largest retail outlets.

Deterioration of the floor had progressed to the extent where repair and maintenance was no longer viable and a replacement solution was sought. Topfloor enabled out-of-commission periods to be reduced due to a shortened construction process and by reducing maintenance requirements. Through its innovative design, sufficient strength was gained within a matter of days to allow trafficking and follow on trades to apply final finishes.

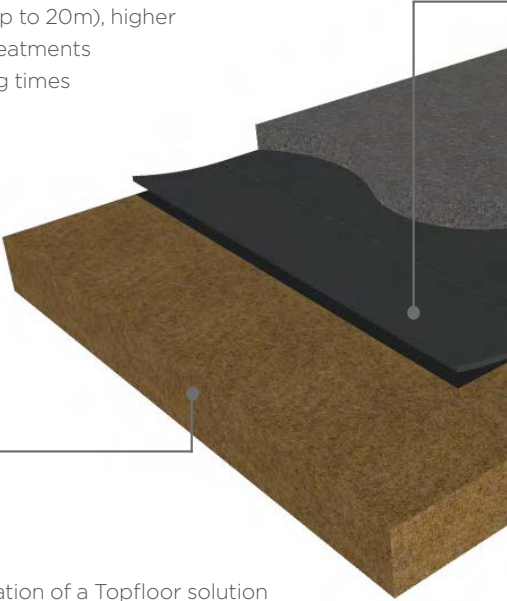
Through early engagement with RG Group (Asda's contractor) and given Topfloor characteristics, joint spacing was extended to align with the terrazzo tile matrix. Consequently the traditional issue

of differential movement at concrete and tile interfaces was reduced, minimising joint breakdown risks, tile damage and subsequent maintenance requirements.

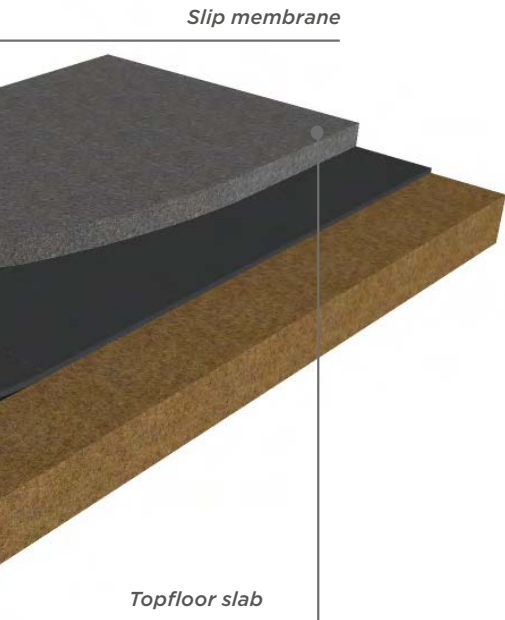
Topfloor is a flooring solution that offers significant performance improvements over existing conventional concrete construction systems.

Topfloor is a high-strength and low-shrink concrete solution. Compared to conventional solutions it offers an increased loading capacity (compressive strength up to 70 N/mm²), increased joint spacing (up to 20m), higher abrasion resistance (without the need for ancillary treatments such as dry shake floor hardeners) and shorter curing times (allowing earlier trafficking). These characteristics can all typically be achieved whilst reducing construction depth, reducing or removing reinforcement, reducing maintenance and increasing design life creating a sustainable solution.

Sub-base

A 3D cutaway diagram illustrating the typical formation of a Topfloor solution. It shows a thick, brown, textured sub-base layer at the bottom. On top of this sub-base is a thinner, dark grey, smooth-surfaced top layer. A thin, dark grey layer is also visible between the sub-base and the top layer. A line with a dot at the end points from the text 'Sub-base' to the brown layer. Another line with a dot at the end points from the top layer to the right side of the diagram.

Typical formation of a Topfloor solution

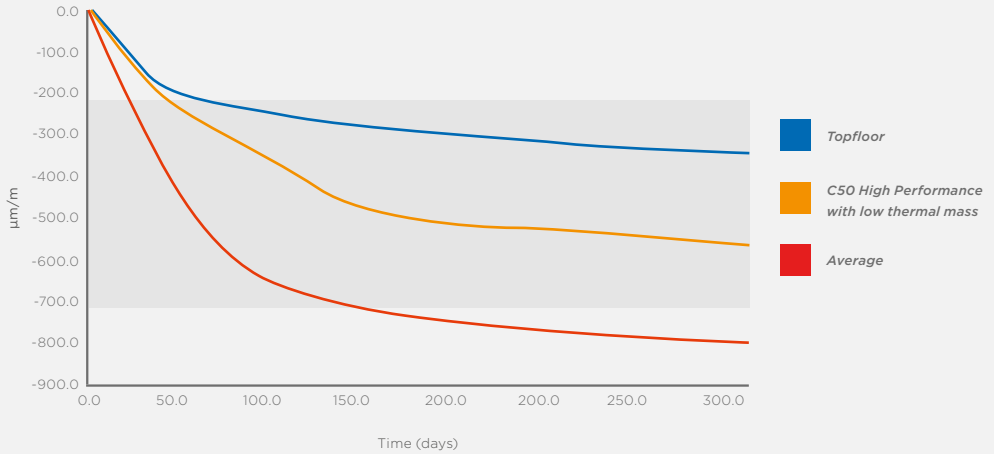


Up to 400m² surface
without joints (20m x 20m)
No reinforcement
No surface hardener

| Performance | Topfloor | Conventional |
|--|--------------|--------------|
| Shrinkage (µm) | 250 - 350 | 500 - 800 |
| Jointing (m ²) | 400 | 36 |
| Slump flow (mm) | >450 | N/A |
| Slump (mm) | >220 | S3 |
| Flexural strength at 28 days (N/mm ²) | Guaranteed 6 | 4 |
| Compressive strength at 28 days (N/mm ²) | up to 70 | 40 |

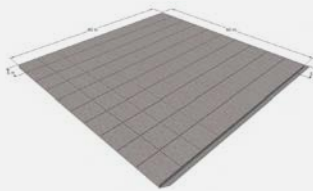
LOWER SHRINKAGE CHARACTERISTICS

For conventional concrete shrinkage is typically between 500-800 $\mu\text{m}/\text{m}$ whereas through the innovative design of Topfloor this has been reduced to 250-350 $\mu\text{m}/\text{m}$, whilst autogenous shrinkage is negated by an initial expansion. This characteristic facilitates changes to jointing, reduction or removal of steel, a reduced risk of curling and shrinkage cracking, and simplified construction and maintenance processes.



INCREASED BAY SIZES

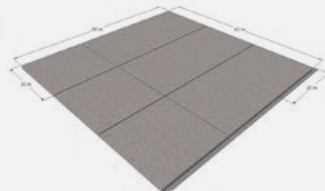
The characteristics of Topfloor enable bay sizes to be extended to 400m² (20m x 20m) and with steel mesh 900m² (30m x 30m) from the traditional 36m² (6m x 6m).



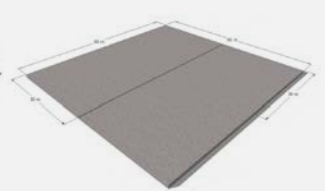
Typical bay layout of a conventional concrete floor slab (6m x 6m)

REDUCED JOINT MAINTENANCE

The increase in bay size leads to a reduction in joints, reducing ongoing maintenance demands and creates greater flexibility for the organisation and positioning of loads.



Typical bay layout of a Topfloor floor slab (20m x 20m)



Typical bay layout of a Topfloor floor slab into steel mesh (30m x 30m)



REMOVAL OR REDUCTION OF STEEL

Topfloor enhanced flexural strength (in excess of 6N/mm^2) and shrinkage performance, compared to conventional concrete, can reduce the reliance on steel reinforcement to provide resistance to tensile forces. In certain applications it is possible to reduce and remove steel minimising the risk of corrosion and issues associated with aggressive environments.

HIGH PERFORMANCE FINISH

Topfloor provides a high quality and resilient surface finish which can achieve an abrasion resistance (AR) class of special ⁵ and can conform to design chemical class (DC) 4 ⁴.

EARLY LOADING OF TOPFLOOR

Construction programmes can be fast tracked Topfloor, as it can gain enough strength in 14 days to allow full loading, compared to conventional designs which can take 28 days.

Further benefits can be sought in renovation and refurbishment applications by reducing out of service periods.

| Days | Strength gain (N/mm ²) |
|------|------------------------------------|
| 1 | 20 |
| 7 | 50 |
| 28 | 70 |

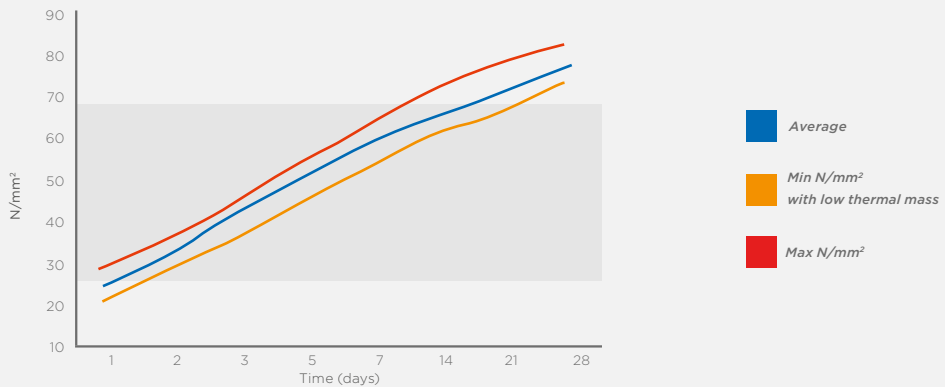


Diagram representing Topfloor strength gain profile



REDUCED ENVIRONMENTAL FOOTPRINT

An Ecobilian[®] study has shown that Topfloor can reduce CO₂ emissions by up to 20%, with reductions in coal and oil consumption of up to 46% and 16% respectively due to reductions in slab depth and removal of steel.

End of life issues linked reinforced slab solutions can be completely avoided by installing an unreinforced Topfloor solution. Slabs containing steel fibres are required to be sent to landfill and by removing the need for reinforcement waste production can be reduced by up to 85%.

SIMPLIFICATION OF CONSTRUCTION

On-site construction with Topfloor facilitates the removal or reduction of several construction operations such as steel reinforcement fixing and jointing, traditionally associated with industrial slab construction.



Early slab finishing via powerfloating

LOW COEFFICIENT OF THERMAL EXPANSION

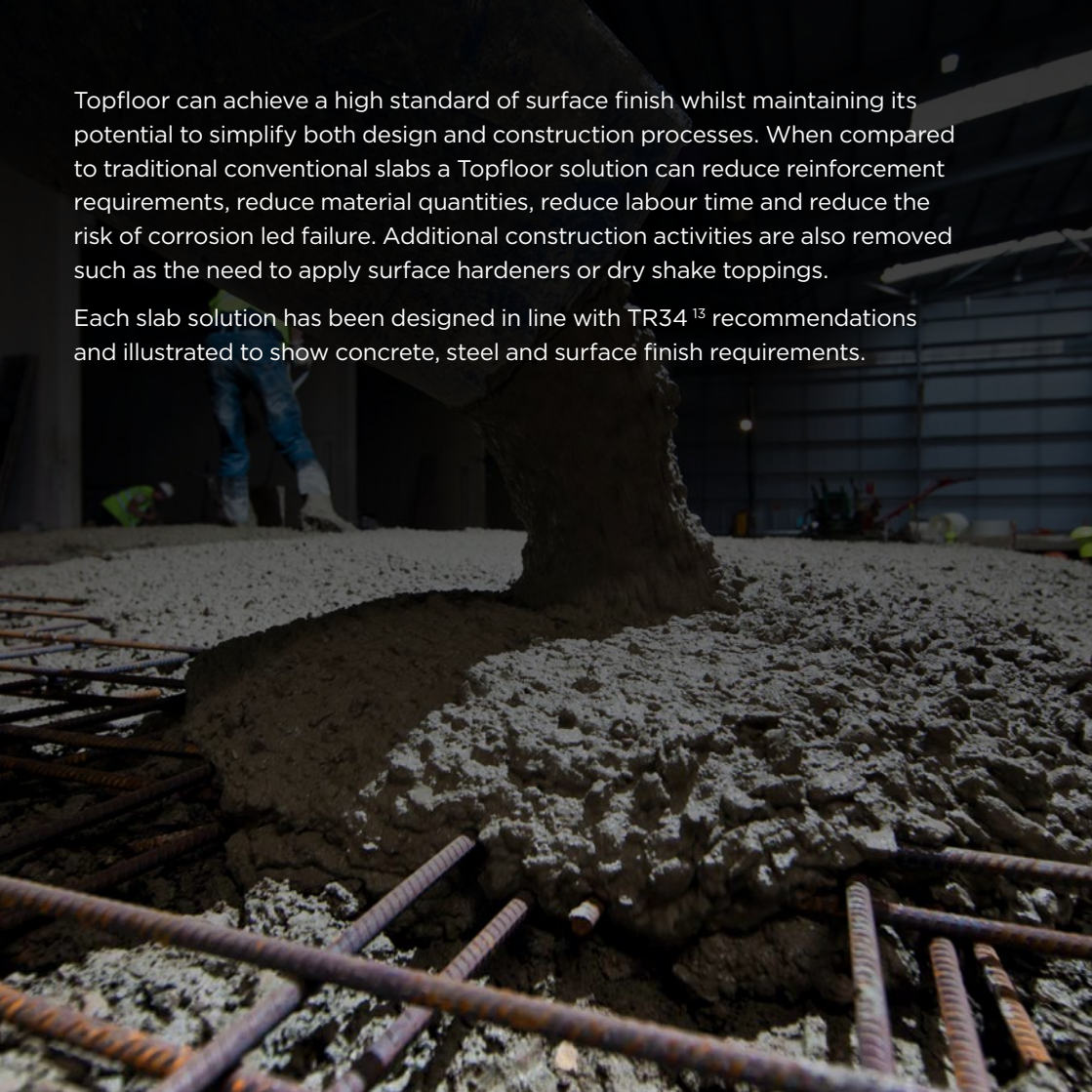
Industrial processes, particularly those linked to the waste and recycling industry, can expose floor slabs to cycles of high temperature that can lead to deleterious actions.

Topfloor has been designed to incorporate aggregates with low values of expansion ($9 \times 10^{-6} \text{ } ^\circ\text{C}$), which compared to conventional concrete, minimises the risk of cracking associated with temperature change.

EARLY SLAB FINISHING

Power floating of Topfloor can commence within 2 to 5 hours of placement, offering programme and scheduling benefits over conventional concrete.

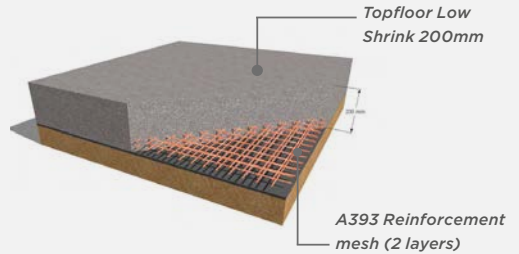
It's gelling process is far more consistent than that experienced with conventional concrete, reducing risks of differential set resulting in an easier to manage floor during the powerfloating phase.



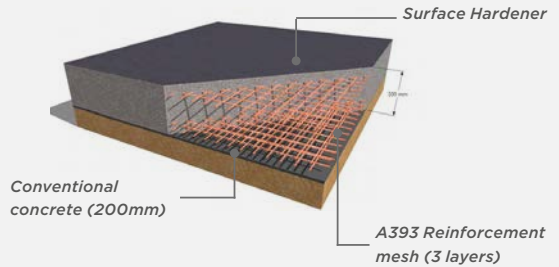
Topfloor can achieve a high standard of surface finish whilst maintaining its potential to simplify both design and construction processes. When compared to traditional conventional slabs a Topfloor solution can reduce reinforcement requirements, reduce material quantities, reduce labour time and reduce the risk of corrosion led failure. Additional construction activities are also removed such as the need to apply surface hardeners or dry shake toppings.

Each slab solution has been designed in line with TR34 ¹³ recommendations and illustrated to show concrete, steel and surface finish requirements.

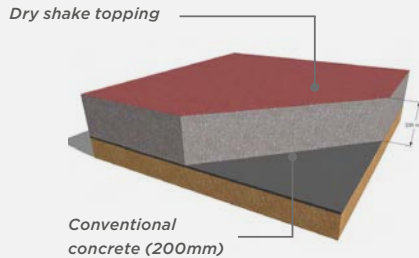
Topfloor AR Special Design



Conventional with surface hardener to achieve AR Special Design



Conventional with dry shake topping to achieve AR Special Design



TOPFLOOR KEY PERFORMANCE FACTORS

As with all concrete construction solutions Topfloor has several steps and precautions that should be observed in order to ensure that its performance is not compromised.

Care should be taken to ensure that preparation, placement and post pour directions are followed, with guidance sort from your Tarmac representative.

CURING

All concrete is required to be cured to ensure that design and performance characteristics are achieved. Curing should be undertaken in a timely manner either in the form of a sprayed curing compound, wet curing or sheeting.

JOINTING

Saw cuts are required to be made to a depth no less than one third of the total slab depth and should be carried out by a trained operative within 24 hours of placement. Premature saw cutting should be avoided as this can result in surface damage.

LOADING

Whilst Topfloor offers the ability to load the slab earlier in its life, the following loading stages should be adhered to;

- 1 Day Access for foot traffic
- 3 Days Access for mechanical loading, scissor lifts, etc.
- 7 Days Access for heavy machinery
- 14 Days Loading of slab



SUSTAINABILITY

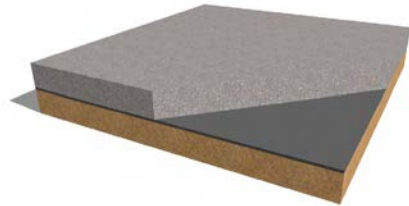
COMPARISON OF ENVIRONMENTAL FOOTPRINTS

An environmental study was carried out based upon the findings of an Ecobilian[®] report, with three specific industrial flooring solutions assessed. System A describes the Topfloor solution, system B is a conventional concrete solution utilising steel fibres and system C is conventional concrete with a single layer of mesh.

Each system has been designed to achieve the same level of performance[®] with the differences in design reflecting the inherent properties of each system. The scope of the analysis has been limited to the production and installation of the slabs. Maintenance, renovation and recycling has not been included. Lifespans for each system have been assumed to be similar for each system with the analysis carried out over a functional unit of 1m².

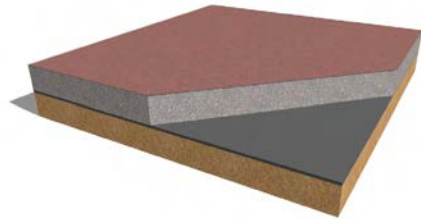
System A

Topfloor 175mm deep bay size
20m x 20m



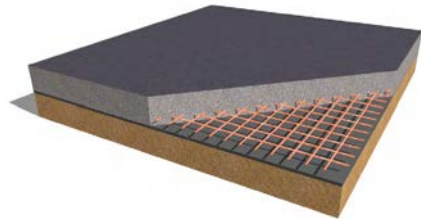
System B

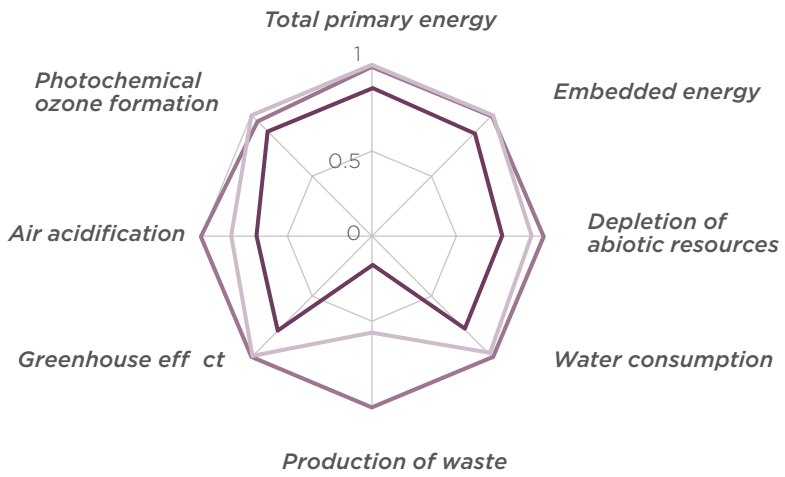
Conventional Concrete with
40kg/m³ steel fibres 200mm
deep bay size, 40m x 40m






System C

Conventional Concrete with
one layer of A193 mesh 215mm
deep bay size, 6m x 6m





-  A - Topfloor
-  B - Conventional concrete with steel fibres
-  C - Conventional concrete with metallic mesh

GREENHOUSE EFFECT

Topfloor slabs can reduce the greenhouse gas emissions by 20% compared to alternative conventional systems, primarily a result of reductions in concrete and steel reinforcement.

RESOURCE OPTIMISATION

Throughout production and installation waste is significantly reduced as material quantities are reduced or removed along with the waste associated with their production.

WATER CONSUMPTION

Topfloor reduces consumed water due to the reduction of concrete and steel, and the associated water that is used in its production.

Photochemical ozone formation is caused by NO_x, VOC and CO which can create low level ozone, this can have a damaging effect on humans at high concentration levels but also on vegetation at low levels.

Air acidification: SO₂ and NO_x are key causes of acidification. When expelled into the atmosphere they can damage and accelerate damage to buildings, with an additional detrimental effect on soil and vegetation.

Primary energy describes energy that is found in nature that has not been subject to a transformation or conversion process.

Embodied energy is the energy required to create and produce the system.

Depletion of abiotic resources is the use of resources that come from non-living and non-organic materials.

RECYCLING

The concrete industry has taken significant steps to improve its performance in terms of material reuse, reducing the depletion of abiotic resources, increasing energy efficiency and reducing carbon emissions. Significant improvements have already been achieved compared to the industry's 1990 baseline⁹.

With respect to material reuse and the depletion of abiotic resources, concrete readily utilises recycled and secondary materials along with cement replacements. This has enabled the industry to be a net user of waste, using 47 times more waste than it generates⁹, and concrete itself is also 100% recyclable¹⁰.

BES 6001*

Tarmac has achieved an 'Excellent' rating for all its production sites and products. The independent third-party scheme assesses responsible sourcing policies and practices throughout the supply chain¹¹.



ISO 14001

Tarmac is fully accredited with ISO 14001, having implemented Environmental Management Systems throughout our business, maintaining our commitment to reducing our environmental impact¹².

¹ Tarmac's concrete products offer the ability to conform with a wide-ranging number of assessment criteria in both BREEAM and LEED. For more information contact Tarmac sustainability team.

* Our BES 6001 certificate number for our readymix concrete products is BES 559207.

SUSTAINABILITY ASSESSMENT SCHEMES

Concrete can play an extended role in enabling an efficient building to be created. Concrete can contribute in a number of assessment schemes and help achieve a range of credits †.

| | BREEAM† | LEED |
|---------------|--|--|
| CREDIT/TARGET | Man 03: Responsible Construction Practices Tarmac's Carbon Calculator has the capability to determine and provide data relating to the CO ₂ arising from production and delivery of our products. | MR Credit 2: Construction waste management Construction and demolition waste is encouraged to be diverted away from landfill or incineration, concrete is an inherently reusable material that is 100% recyclable. |
| | Mat 03: Responsible sourcing of materials Concrete is primarily constituted of locally available materials, all concrete products produced by Tarmac are BES 6001 accredited to an 'Excellent' standard. | MR Credit 4: Recycled content Concrete is a versatile material whose design can be readily adapted to enable the use of recycled, secondary or replacement materials. |
| | Wst 02: Recycled Aggregates Concrete is a versatile material whose design can be readily adapted to enable the use of recycled, secondary or replacement materials. | MR Credit 5: Regional materials Concrete is one of the few materials that is produced locally to where it is used; it can typically be supplied from within 10 miles of any given site. |
| | Hea 02: Indoor Air Quality Concrete can help achieve a healthy internal environment, as a relatively inert material which emits extremely low levels of volatile organic compounds and through passive solar design. | |
| | | |

PEOPLE



Safety and health
Our people
Community involvement

PLANET



Climate change
Environmental stewardship
Resource efficiency

PERFORMANCE



Economic value
Governance and ethics
Communication

SOLUTIONS



Sustainable supply chain
Innovation and quality
Sustainable construction

OUR SUSTAINABILITY STRATEGY

Sustainability is about securing long-term success for our business, customers and communities by improving the environmental, social and economic performance of our products and solutions through their life-cycle. This means considering not only the goods we purchase, our operations and logistics but also the performance of our products in use and their reuse and recycling at the end of their life. By doing this, we can understand and take action to minimise any negative aspects, while maximising the many positive sustainability benefits our business and products bring.

Using this 'whole life' thinking we have engaged with our stakeholders to develop our sustainability strategy. The strategy defines the main sustainability themes and our key priorities, those issues which are most important to our business and our stakeholders. It sets out our commitments to transform our business under four main themes: **People, Planet, Performance and Solutions**.

Building on progress already made, we have set ambitious 2020 milestone targets for each of our key priorities. These ambitious targets have been set to take us beyond incremental improvement programmes to business transforming solutions.

FOUR THEMES

Twelve key priorities

Twelve commitments

Twelve 2020 milestones

Forty four other performance targets

Our 2020 milestones are supported by a range of other performance targets.

This hierarchy helps make it easier to build understanding, drive improvement and enables us to report progress in a meaningful and measurable way.

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T3 Tarmac, Ground Floor, T3 Trinity Park

Bickenhill Lane, Birmingham, B37 7ES

For more details visit tarmac.com/contact

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