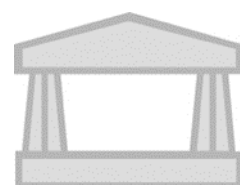




Natural Stone ▪ Swimming Pools

Selection ▪ Design ▪ Use ▪ Maintenance



Federation
Stone
Great Britain



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Stone Federation Great Britain

Stone Federation is the national trade association for the natural stone industry with over 100 years' experience in connecting architects, designers, specifiers and clients with the finest stone professionals and materials.

The Federation is passionate about promoting natural stone as the building material of choice as well as the source for all things stone.

Stone Federation provides an invaluable aid to all those seeking sources of natural stone or wishing to employ a specialist natural stone professional.

For further information about Stone Federation, visit our website, www.stonefed.org.uk.



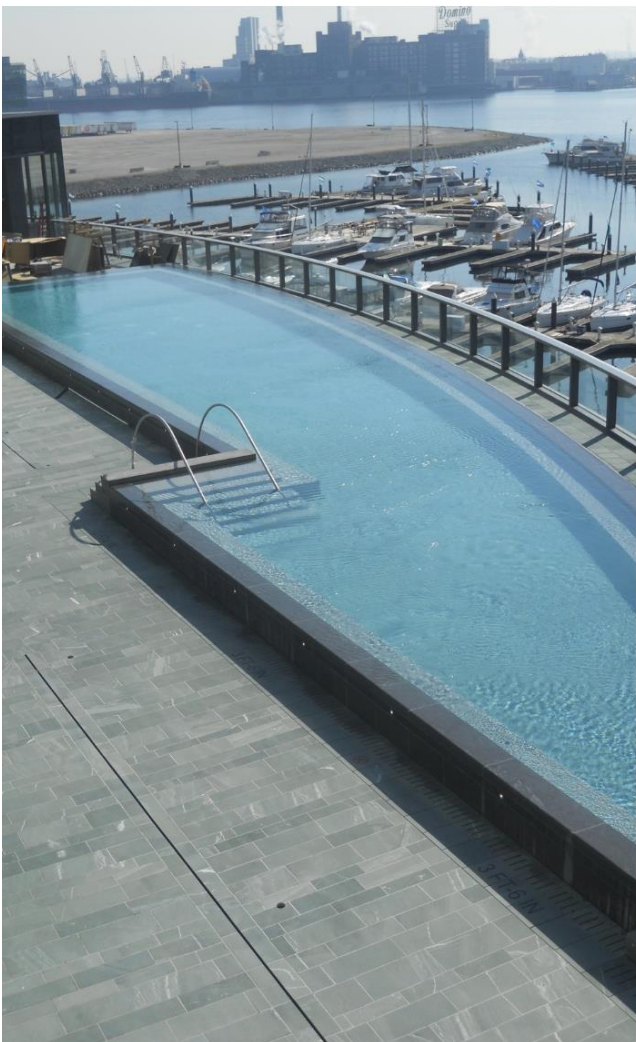


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1.0 Introduction

1.1 General

A significant demand has developed in recent years for natural stone to provide the decorative finishes to swimming pools and their surroundings.

1.2 Aims and scope of this document

This Stone Federation Great Britain Guide is intended to provide advice on the use of natural stone in and around swimming pool locations. Wide ranging experience in the use of natural stone for swimming pool installations has been gathered from industry, which forms the basis of the information provided. Additional advice has also been sought from swimming pool specialists in relation to water treatment systems.

Where applicable the Guide is based on the relevant parts of a number of British Standards relating to the design, supply and installation of natural stone and incorporates requirements of current good practice. The Guide also uses information from relevant sources and current UK health and safety legislation and advice.

1.3 Limitations to scope and associated guidance

This Guide cannot provide guidance on how to build swimming pools and only considers the principal influences that the supporting construction may impart.

Water composition and management is typically outside the control of those engaged in the stone selection and installation. Therefore emphasis must be placed on selecting stones and their adhesive backings that are generally resistant to the environmental stresses they may be expected to encounter.

This environment requires the use of a range of chemicals that presents a number of potential issues that natural stone must resist, and which need careful consideration.

Reference is made in this Guide to relevant advice from other Stone Federation GB guidance dealing with the use of natural stone in the design and installation of internal flooring and in wet rooms, steam rooms and shower enclosures (see Appendix).

1.4 Key factors to be considered

The selection of any type and size of stone unit should ensure, as far as possible, that it is suitable for the application and in-service use required by the designer. Satisfactory experience in a similar application may provide useful additional information but must not be solely relied upon.

Key factors that should be taken into account for the use of natural stone in the construction of pool environments include:

- Stone selection and aesthetics
- Water treatments
- Durability
- Discoloration resistance
- Slip resistance (for pedestrian areas and ramps within and around pools)
- Staining resistance
- Backing materials
- Cleaning and maintenance

2.0 Swimming pool zones

2.1 Introduction

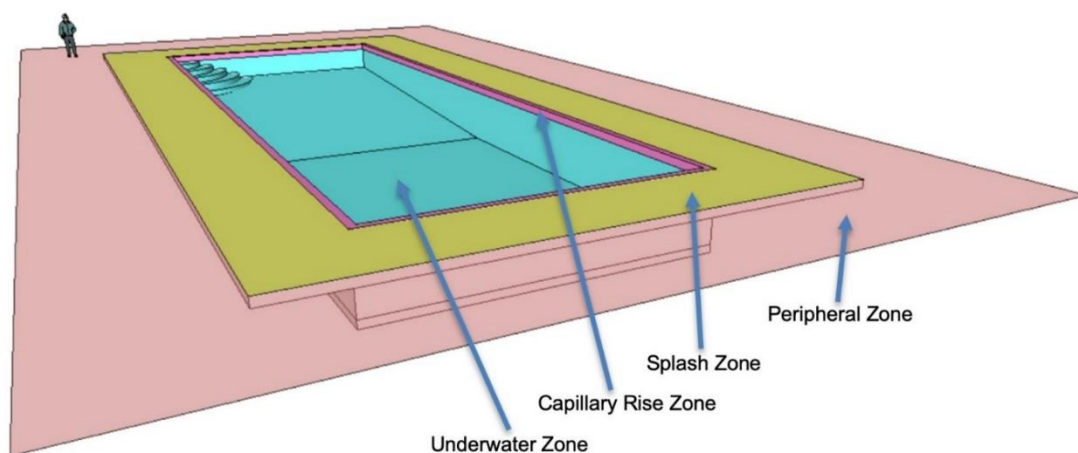
There are different zones in and around a swimming pool environment that are subjected to different levels of water contact, its added chemicals and the external environment.

There are four different environmental zones and these are identified below, and shown in Figure 1:

- Peripheral zone
- Splash zone
- Capillary rise zone
- Underwater zone

The four zones are reflective of different environments and influences that are likely to impact to varying degrees on the performance and appearance of natural stone.

Figure 1 The zones in and around the swimming pool: peripheral, splash, capillary rise and underwater zones.



2.2 Local environmental differences

2.2.1 Underwater zone

The underwater zone is generally a stable one.

Problems may become manifest when the pool is emptied (see 2.3).

2.2.2 Capillary rise zone

The area immediately above the water line is the capillary rise zone. All natural stone, whether porous or otherwise, has the ability to transport moisture via natural capillaries between the constituent grains and/or crystals, and with it, dissolved salts. Water is drawn through the stone upwards from the water line and may have the potential to rise up to around 2 m in height from this point.

As salts are drawn through stone they may react and lead to both staining and discoloration issues. Concentration of formerly dissolved salts might lead to the rise of salt weathering.

It should be a consideration to use more robust materials and incorporate a break at an appropriate position in order to curtail capillary uptake close and around the water line.

2.2.3 Splash zone

This area is immediately beyond the capillary rise zone where water from the pool may splash during normal use. The splashed water from the pool will be taken away from the pool edge by positive falls so that it does not wash back into the pool and bring with it dirt and other materials. This region of random cyclic wetting and drying may be subject to increased salt precipitation, but significantly less than that occurring in capillary rise zone.

2.2.4 Peripheral zone

This zone is outside of the splash zone and surrounds a swimming pool. The peripheral zone may exert a number of influences upon the performance of the stone. It may be found immediately adjacent to the pool edge if there is no apron construction. The principal issue with such a zone is the way in which it may feed water along with dissolved salts into the construction.

When it comes to natural stone for use in and around swimming pools, there is no definitive advice covering design, installation and maintenance. To date, the focus of available guidance has been on the use of ceramic materials, with natural stone being seen as a material requiring specialist advice.

The main standards and guidance currently available within the UK relating to the use of natural stone in the swimming pool environment have been listed in the Appendix.

2.3 Hydrostatic pressure considerations

When a pool is filled with water, the head of water that is created exerts a downwards pressure on the floor and lateral pressure on the walls. Where the substrate materials have become gradually saturated, the moisture present becomes pressurised. If the pool water is drained, there is no confining pressure to the pressurised substrate materials and if this pressure cannot be released it pushes against the surface finish. The hydrostatic pressure imbalance created is believed, in numerous situations, to be the cause of finishes suffering detachment, usually by debonding.

2.4 Types of natural stone and the importance of classification

The classification of natural stone is carried out with reference to BS EN 12440, which for individual materials (in the UK and Europe) identifies the geological name, traditional name, quarry location and country of origin. To define the correct geological name and classification of a stone, testing to BS EN 12407 is carried out, which involves the petrographic examination of a stone, potentially supported by a range of analytical techniques.

2.5 The advantages of natural stone

Some of the potential advantages of using natural stone in the pool environment are:

- It can be cut, shaped and textured unlike many artificial materials
- Curved surfaces can be created rather than resorting to mosaic work that is more susceptible to potential moisture flow to the backing materials
- Potentially easier to replace than ceramic and other materials that may go out of production
- Great variety of choice and unique aesthetic options

2.6 Stone suitability

The table provides some initial guidance only and does not remove the need for assessment of material suitability in each project. The individual merits of a stone should always be considered before use.

Table 1 Suitability of natural stone

Stone type		Floors	Walls
Marble		A	A
Limestone		A-D	A-D
Onyx		B	A
Natural Quartzite		A	A
Slate		A	A
Granite		A	A
Sandstone		E	E

Key:

A – Materials that can be used in all situations and where the risk of damage is extremely low.

B – Care is needed when using sharp objects not to scratch the surface.

C – Although these materials have been used in all situations it must be realised they are not as hard as A or B materials and suitable precautions must be taken.

D – Only the most suitable material should be considered. .

E – This material type is likely to be difficult to use in these specific circumstances.

2.7 Water treatments

Water treatments in pools are usually chemically based and may react with the stone, so specialist advice should be sought and testing carried out.

3.0 Performance considerations

3.1 Introduction

There is some guidance and established performance requirements for natural stone flooring and paving (e.g. slip and abrasion resistance), that could be applied to pool surrounds and floors, whether internal or external.

Used internally or externally, natural stone needs to offer appropriate slip and abrasion resistance, but additionally resistance to salt crystallisation and chemical attack, especially that leading to discoloration and staining issues.

For external environments, the effects of frost and heating/cooling cycles need to be taken into account. The application of treatments, usually applied to stone surfaces, is also an important subject for consideration.

3.2 Slip resistance

The slip resistance of natural stone requires careful evaluation in order to minimise the potential risks. Stone Federation has produced a document, “Slip Resistance, testing, assessment and guidance”, which provides detailed insight into the issues surrounding slip and how to test. This also includes the correction that should be applied to the minimum slip resistance value when the surface is sloping, which will be applicable to many pool surrounds.

In consideration of both the issues presented by a swimming pool environment and the inclined nature of the draining surface, it is recommended that a minimum pendulum slip resistance (BS EN 14231) of PTV 40 (55 rubber slider for barefoot) is used for swimming pool environments regardless of location and other factors.

3.3 Salt resistance

A swimming pool environment produces a constant challenge to keep the pool water at an ideal pH that often involves the regular addition of chemicals and minerals, which may become concentrated. This is counter-balanced by introducing new water that will itself contain a proportion of dissolved salts, whether this is potable water, seawater, or that from other sources. Wherever the pool water falls upon the stone or is drawn through it due to capillary action, as drying occurs, the dissolved salts may concentrate and eventually precipitate. It is where salts precipitate that can be an issue, as these salts not only sometimes result in staining but may also be detrimental to the stone. The salt crystallisation test (BS EN 12370) investigates the properties of salts and how they may affect natural stone.

3.4 Discoloration

The aesthetic performance of the stone is very important and swimming pool water can impact on this in both the short and long term.

Discoloration may occur in some stones where not correctly selected due to the breakdown of naturally occurring metallic components such as pyrite, marcasite, pyrrhotite and haematite. These can lead to iron staining that looks like rust, which can be extremely difficult to remove.

A discoloration that affects some limestones is the movement of naturally contained organic matter. Limestones should be checked for organic discoloration potential and there are ad hoc partial immersion tests using alkaline water that may be employed in order to assess this.

There is test standard (BS EN 16301) for assessing the sensitivity of stone to accidental staining.

3.5 Frost resistance

Where the climate dictates, all stones used externally for pool surrounds must demonstrate frost resistance. Careful consideration needs to be undertaken in high risk areas such as the capillary rise zone.

The selection of a stone and its durability performance must be specifically evaluated in respect of the expected environmental exposure conditions in the installation

3.6 Flexural strength

The strength of the stone should always be reviewed in light of its location and whether it is expected to carry more than just normal pedestrian loads. Guidance is provided in BS 7533 Part 101 and BS EN 1341.

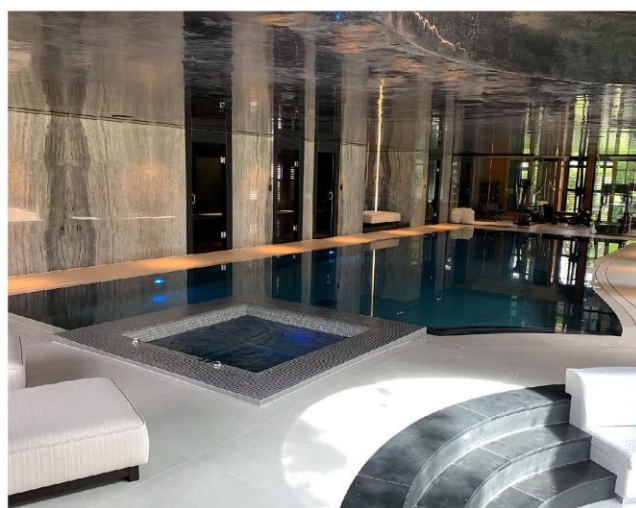
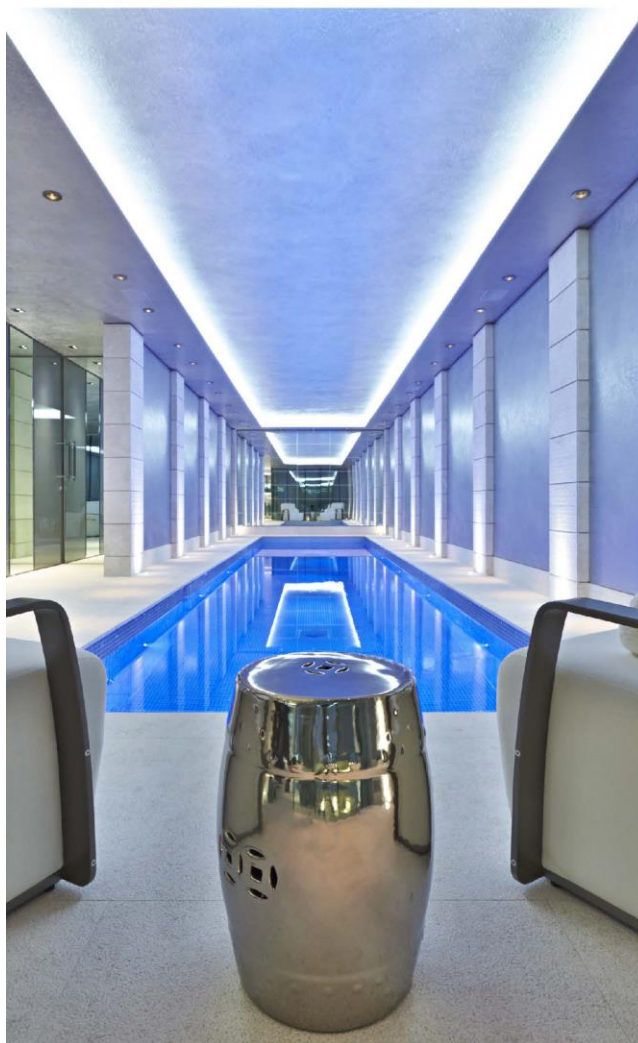
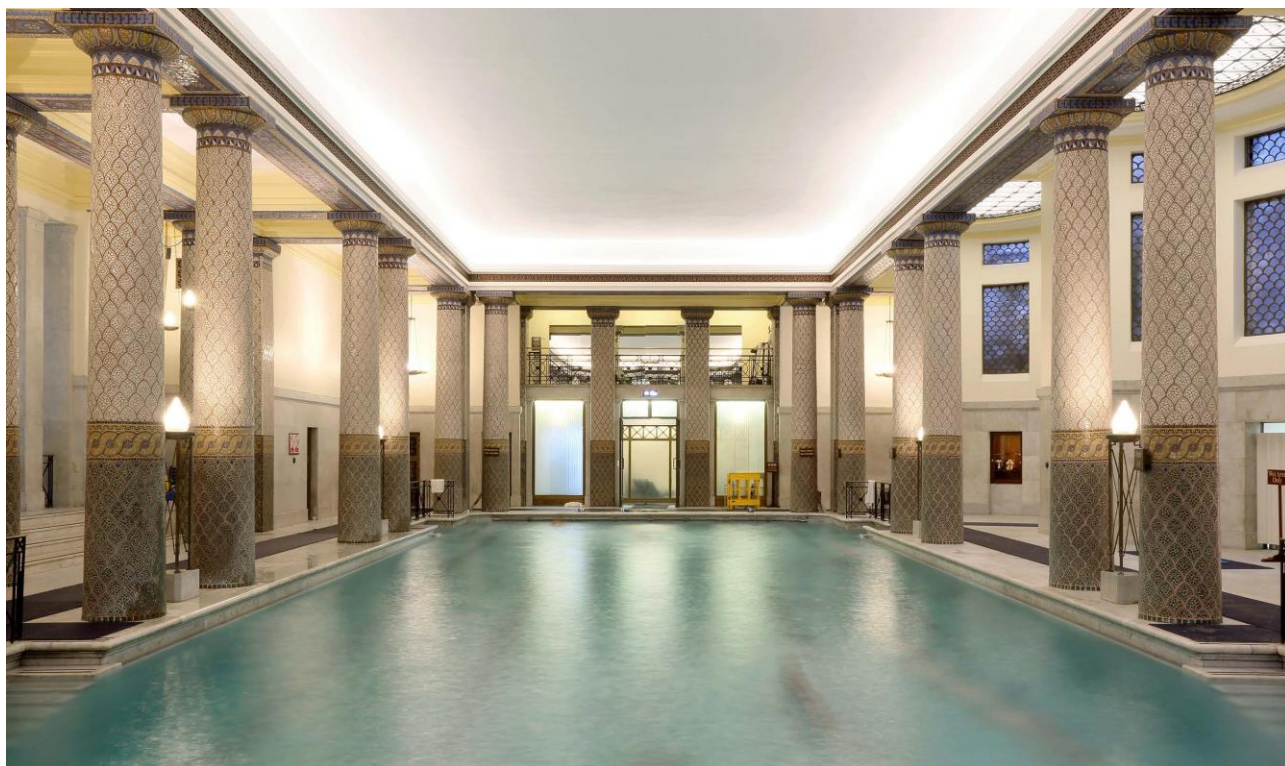
3.7 Thermal properties

Black surfaces absorb light and radiation more than white surfaces and therefore suffer more from heating issues during sunny periods.

Stone can also be subject to thermal expansion and contraction when used inside a pool. Where applicable, stone should be tested for thermal expansion.

3.8 Thermal shock resistance

In some situations, rapid changes in stone temperature range can induce a detrimental effect. If this is a potential concern in a specific application, the impact of thermal shock to natural stone can be investigated (BS EN 14066).



3.9 Wetting and drying properties

Where applicable, wetting and drying expansion should be considered and evaluated.

4.0 Stone assessment

4.1 Introduction

Depending on actual use, all stone should be supplied with a DoP (Declaration of Performance) and CE Marking and UK CA Marking to BS EN 12058, BS EN 12057 Tiling and/or BS EN 1469 Cladding.

Table 2 Recommended tests available for different stone uses.

Stone properties for evaluation include			
Standard Specification		BS EN 12057/12058	BS EN 1469
Stone Unit Function		Tiles/Slabs	Cladding Slabs
Test Property	Standard		
Capillarity	BS EN 1925	Recommended	Recommended
Density & Porosity	BS EN 1936	Recommended	Recommended
Salt Crystallisation	BS EN 12370	Recommended	Recommended
Freeze-Thaw Resistance ¹	BS EN 12371	Recommended	Recommended
Modulus of Rupture	BS EN 12372	Recommended	Recommended
Petrography	BS EN 12407	Recommended	Recommended
Water Absorption	BS EN 13755	Recommended	Recommended
Thermal Shock Resistance	BS EN 14066	Recommended	Recommended
Slip Resistance ²	BS EN 14231	Recommended	Not applicable
Thermal Expansion	BS EN 14581	Recommended	Recommended

Notes

1 – Freeze-thaw resistance – only undertaken where materials are to be used externally.

2 – see appendix for SFGB slip resistance document.

Advice should be sought from a stone specialist on the interpretation of test results.

4.2 Petrographic examination

The constituent components and characteristics of the stone should be established microscopically. Particular features such as stylolites (which affect many limestones) should be carefully investigated.

4.3 Frost cycle testing – external areas only

The frost testing for external flooring in accordance with BS EN 12058 is run over a minimum of 56 cycles following BS EN 12371 Technological Test procedures.

4.4 Adhesion testing

A proprietary adhesive with proven performance should be compatible with any waterproofing or rendering products installed by the pool contractors.

5.0 Design of stone finishes

5.1 Introduction

This Guide cannot provide detailed advice on the structural design and construction of pools. It only provides advice on the natural stone 'finishes' used and how best to install these.

The design and construction of these various finishes is covered by the following standards and documents that are available:

- BS 5385 – Tiling standards
- BS 7533 – Paving standards
- BS EN 1341 – Natural stone pavers
- BS EN 1342 – Natural stone setts
- BS EN 1343 – Natural stone kerbs
- BS EN 12057 – Natural stone modular tiles
- BS EN 12058 – Natural stone slabs
- BS EN 12059 – Dimensional stone work requirements
- SFGB Code of Practice for Natural Stone Flooring
- SFGB Guide to Installation in Bathrooms, Shower Enclosures & Wet Rooms

6.0 Ancillary materials used in and around swimming pools

6.1 Introduction

As far as fixing natural stone units is concerned, it needs to be confirmed that the pool construction has been carried out correctly and tested before installation commences.

It is generally good practice to allow a period of around 3 weeks after completion before water is introduced (no greater than a depth of 750 mm per day).

The methods used to create watertight construction can differ. It is important to ensure that the surface to be covered is suitable to receive the selected adhesive and is prepared correctly.

6.2 Grout

In a swimming pool installation grout can be either cementitious or reaction resin.

Cementitious grout, modified with polymers, should be considered with hard water or where water is maintained at a calcium level over 200mg/lit expressed as calcium carbonate.

White cementitious grout is not recommended for pool surrounds or changing room flooring.

Reaction resin grouts should be considered with soft water (low calcium) or in aggressive, intensive cleaning or high level abrasion environments.

Epoxide resin can also be considered as it is;

- Acid resistant
- Pool water resistant
- Impervious
- Protective of the subsurface

6.3 Flexible sealants

Ensure that the correct type of sealant is used to accommodate the anticipated levels of movement and that it will not stain or attack the stone to which it will be attached.

Sealant manufacturers should be requested to confirm that their product(s) would be compatible with the proposed swimming pool environment.

6.4 Stone treatments

The use of any stone treatment in an external environment should be carefully considered.

Before the use of any treatment with natural stone, specialist advice should be sought as to its potential performance in the expected environmental exposure conditions in the installation area.

6.5 Maintenance of stone treatments

This should be undertaken in accordance with manufacturers guidelines and recommendations.

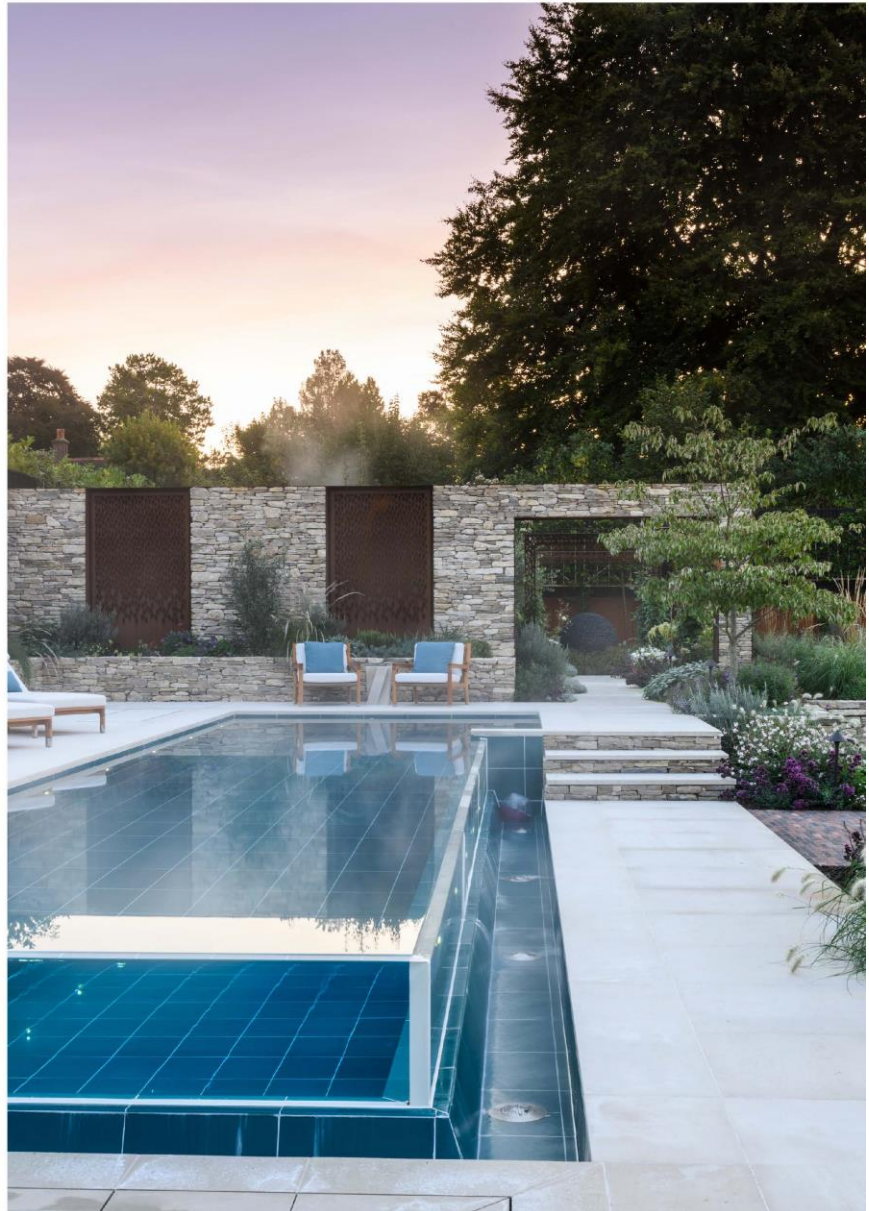
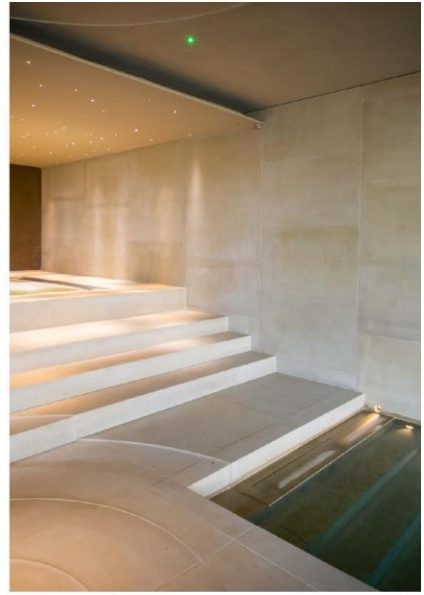
6.6 Stone fixings

Where natural stone slabs, as defined in BS EN 1469, are used as wall lining, they need to be set on a full bed of adhesive and mechanically fixed. Depending on the type of backing structure it may also be necessary to install load-bearing support brackets at the base of the stone. Where stone is fixed to the pool wall and submerged or partially submerged, mechanical fixings cannot be used. Therefore, accuracy in the construction of the backing wall, and the application of the adhesive bed, to achieve a full bed, is critical.

6.7 Grades of metal used in swimming pool environments

Stainless steels have been successfully used for certain applications in swimming pool environments for many years. However, careful consideration needs to be given to the risk of stress corrosion cracking of structural load bearing components. This subject is well documented, and guidance exists on the use of load bearing stainless steel in BS EN 13451 [Swimming pool equipment - General safety requirements and test methods for equipment installed in pools for public use].

BS EN 13451 contains a normative annex which provides explicit recommendations for the selection of stainless steel for load bearing applications. Where components are not accessible for regular cleaning the selection of alloys is generally restricted to highly alloyed super-austenitic alloys. In cases where maintenance and regular cleaning might be feasible the choice of alloy include more conventional austenitic and duplex stainless steels.



Appendix – Relevant standards and guidance

British Standards

The following standards have been identified as containing advice pertaining to swimming pools and related structures. Where appropriate the advice provided is briefly considered.

All standards referenced below should be the latest version.

BS 5385

Wall and floor tiling. Design and installation of ceramic and mosaic tiling in specific conditions. Code of Practice.

This part of BS 5385 does not mention natural stone but remains the only standard that deals specifically with the recommendations on design considerations and on the installation of wall and floor tiling in situations where there are specific environmental or functional requirements, notably wet areas. It gives recommendations on the choice of materials, application practices and, where appropriate, on the design of backgrounds and structural bases. This part of BS 5385 expands the recommendations given in BS 5385-1, BS 5385-2 and BS 5385-3 that cover more standard conditions of tiling.

BS 7533 Pavements constructed with clay, concrete or natural stone paving units. Code of Practice for the structural design of pavements using modular paving units.

This Standard deals with external pavements constructed using natural stone in addition to concrete and clay pavers and some parts may be considered applicable to external swimming pool aprons. Some of the advice also might be applied to the way in which swimming pools are constructed in consideration of the forces that may be exerted.

BS EN 13451-1

Swimming pool equipment. General safety requirements and test methods.

This is one of a suite of standards dealing with pool equipment. Careful reference will be necessary where any special situations are created using natural stone. For example, how entry/exit ladders are attached to natural stone, or how steps perform are potential considerations.

BS EN 15288-1

Swimming pools for public use. Safety requirements for design.

This Standard deals with safety measures and their design and layout, including warning devices, signs, lighting levels and other aspects. Potentially the requirements may impact on both colour and finish of natural stone.

BS EN 15288-2

Swimming pools for public use. Safety requirements for operation.

This Standard looks at on-going health and safety management including accident prevention. This has a potential impact on surfaces and how they are maintained to ensure sufficient slip resistance, for example.

BS EN 1992-3

Design of concrete structures. Part 3: Liquid retaining and containment structures.

This Standard is also referred to as Eurocode 2.

Eurocode 2 deals with the design of concrete structures.

This is typically the background selected for swimming pools clad using natural stone. This provides advice on the level of 'tightness' to liquid or gaseous diffusion that may be experienced by a concrete structure. The various considerations are generally well outside the scope of those applying the natural stone finish. The main consideration with a concrete pool is to create a monolithic structure where the walls are continuously connected to the floor, and that is sufficiently robust to not require movement joints.

Other available standards

BS ENs 15031, 15032, 15072, 15073, 15074, 15075, 15076, 15077, 15078, 15362, 15363, 15513, 15514, 15796, 15797, 15798, 15799 and 16038

These standards each deal with a specific chemical that may be used in the treatment of water in swimming pools.

BS 1069 deals with the safety requirements and test methods for water slides.

BS EN 14891 deal with liquid applied water impermeable products for use beneath ceramic tiling bonded with adhesives.

This Standard notes that such materials may be used where natural stone is being deployed instead of ceramic tiling.

BS EN 15836 deals with PVC membranes for in-ground swimming pools.

BS EN 60598 deals with luminaires used within swimming pools and similar environments.

Other available advice

Swimming Pool and Allied Trades Association (SPATA) - <https://www.spata.co.uk/>

Guides cover design, installation, maintenance and safety of domestic and commercial swimming pools aimed at designers, installers, engineers and customers.

Health and Safety Executive - <https://www.hse.gov.uk/pubns/books/hsg179.htm>

Publication provides guidance for those involved in the operation and management of swimming pools (refers to design).

Stone Federation Great Britain (SFGB)

SFGB have published the following advice that may be appropriate to some parts of swimming pool design, installation and maintenance employing natural stone.

Natural Stone – Installation in Bathrooms, Shower Enclosures and Wet Rooms. Much of the advice provided may be translated to the peripheral areas of internal swimming pools. The guide includes advice on tanking both floors and walls.

Natural Stone Flooring. Provides advice on laying natural stone on to a variety of surfaces, including concrete, timber and pedestals in a number of situations and is mainly applicable to the peripheral areas of a swimming pool environment rather than the pool itself.

Slip Resistance Testing Assessment and Guidance. This is useful for swimming pools because of the importance of safety around the pool. The advice concerning slopes is of particular note given the positive drainage pools require and the ramping typically included within pools.

Selecting the Correct Stone. This provides advice on the requirements for sampling and testing stone to ensure compliance with applicable Standards but does not directly deal with stone to be used within swimming pool environments.

CE Marking and UKCA Marking - A Concise Guide. This discusses the Construction Products Regulation and its impact on the use of natural stone in construction, which is relevant to the use of stone either as paving, tiling or cladding in and around a swimming pool. This is briefly discussed further in Section 3.1 of this guide.



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Stone Federation Great Britain
Channel Business Centre
Ingles Manor
Castle Hill Avenue
Folkestone
Kent CT20 2RD

T: 01303 856123
E: enquiries@stonefed.org.uk
W: www.stonefed.org.uk



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