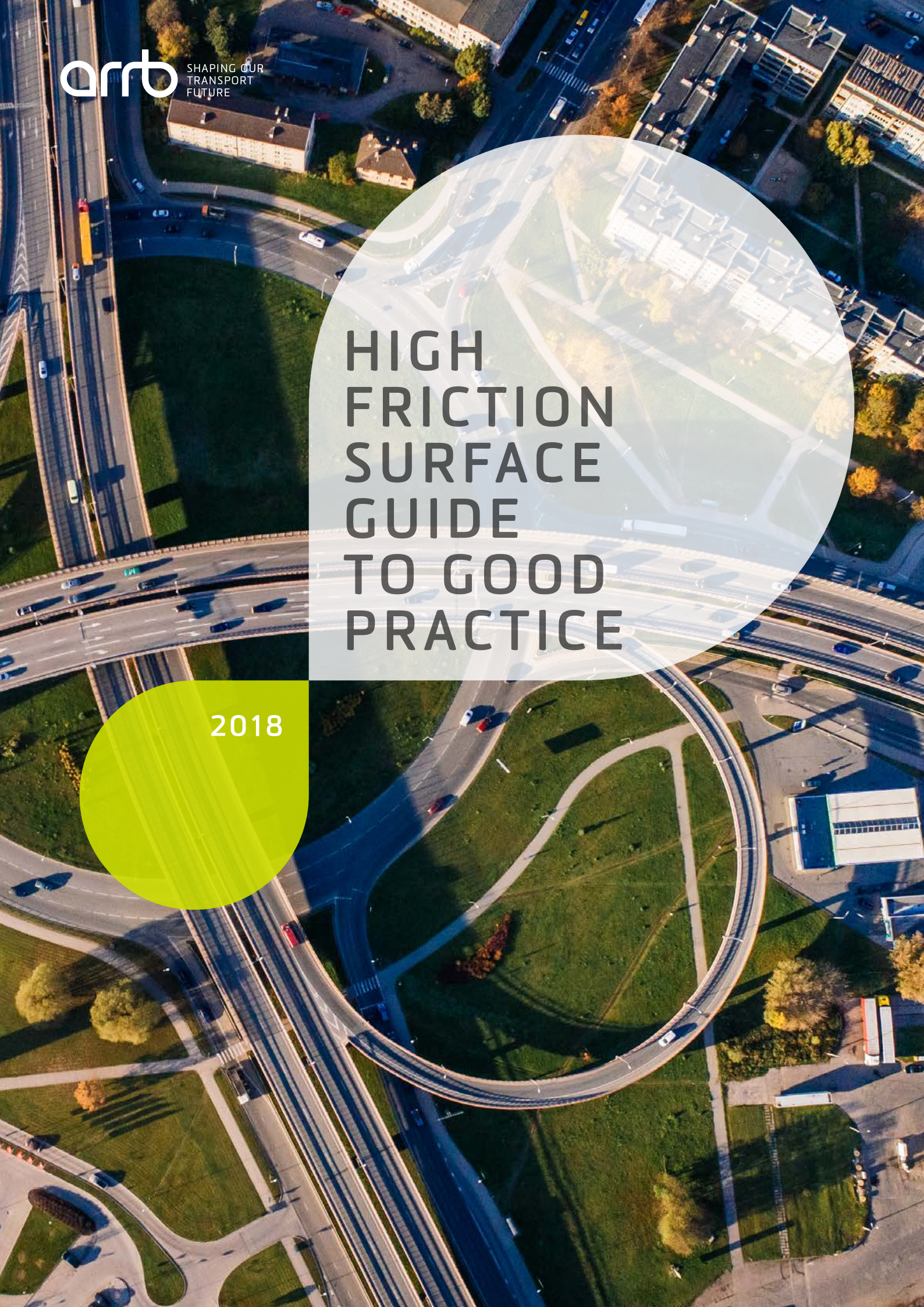


HIGH FRICTION SURFACE GUIDE TO GOOD PRACTICE

2018

SHAPING OUR TRANSPORT FUTURE

About ARRB

Australian Road Research Board (ARRB) provides research, consulting and information services to the road and transport industry. ARRB applies research outcomes to develop equipment that collects road and traffic information and software that assists with decision making across road networks. ARRB is the leading provider of road research and best practice workshops in Australia.

CONTENTS

TABLES

1 INTRODUCTION

These guidelines aim to ensure good value and a high level of performance in the application of High Friction Surface Treatments (HFST), on roads and highways identified as being in the highest-risk category and which require a high level of surface friction.

The guidelines represent good practice for the selection and application of HFSTs, and were prepared to assist road asset managers and engineers, particularly at a local government level, to maximise their performance and durability.

HFSTs are essential in many locations on the network to keep the road surface adequately safe for road users. They are commonly used at accident blackspots, and approaches to intersections and pedestrian crossings.

To obtain good results it is necessary to consider a wide range of details, to plan and design the work carefully, using contractors and products that are fully compliant with the model specification for works as per Appendix A. The model specification is intended to be used as a framework for the development of local government, state, or national specifications.

The types of application in which these products are used and the prevailing ambient conditions at the time of installation are important to ensure long-term durability of the product.

The purpose of these guidelines is to identify the important aspects of the process, and to refer to other documents as required that may provide practical guidance on delivering the highest possible performance in respect of HFST.

2 DEFINITION OF A HFST

For the purposes of these guidelines, a HFST should comprise a polymer resin adhesive binder that bonds a high Polished Stone Value (PSV) / low Aggregate Abrasion Value (AAV) aggregate, typically a graded 1-3 mm calcined bauxite, to the road substrate.

Polymer resin binders are installed as a continuous film of adhesive, onto which the calcined bauxite aggregate is placed. Once the binder has cured, excess aggregate is removed by sweeping.

The binder must hold the aggregate permanently in position without encapsulation of the aggregate. Encapsulated systems of any description are not included in these guidelines.

Polymer resin binder formulations may encompass epoxy, polyurethane, polyurea, or methyl methacrylate.

3 EXPECTED DESIGN LIFE

A survey of HFST in the United Kingdom issued by the Association of Directors of Environment, Economy, Planning and Transport (RSTA/ADEPT 2017) suggested that the average design life of a HFST was between 8 and 12 years.

Studies of HFSTs placed across Australia and New Zealand have indicated that the majority of the calcined bauxite HFSTs have been composed of a thermosetting epoxy compound and are providing a service design life of eight years plus. The oldest recorded site was installed in 1998 and, whilst nearing the end of its functional service life, it is still serviceable after 19 years.

The effective use of HFST requires consideration of the volume of commercial vehicles using the lane (Table 1). To ensure a satisfactory outcome for HFST, the appropriate type must be applied for the traffic conditions.

Research and development conducted in the United Kingdom has demonstrated that HFST which is compliant with the Type 1 laboratory performance criteria detailed in Table 2, and when placed in locations as detailed in Table 1, will provide an expected service life of 5 to 10 years under UK traffic conditions.

Table 1 Area of application and maximum traffic level

SITE CATEGORY		SITE DEFINITION	MAXIMUM TRAFFIC LEVEL (HEAVY VEHICLES/LANE/DAY)
UK (HD28/15)	AUSTRALIA		
Q	3	Approaches to and across all major road junctions	3 500
G1	3	Gradient – 5% to 10% longer than 50 m	
S1	3	Bend radius > 500 m dual carriageway	
R	7	Roundabout	
G2	2	Gradient – >10% longer than 50 m	2 500
S2	6	Bend radius < 500 m dual carriageway	
K	1	Approach to hazard, such as roundabout, traffic signals, pedestrian crossing, rail level crossing	2 500

Table 2 TRL's Type 1 laboratory performance criteria (Nicholls 1997)

TEST		PARAMETER	TYPE 1
Scuffing	Initially	Texture Depth (mm) SRV	≥ 1.4 ≥ 65
	Scuffing after 500 wheel passes at 45 °C	Texture Depth (mm) Erosion Index	≥ 1.2 ≤ 3
	Scuffing after 500 wheel passes after 112 days heat aging at 70 ±3 °C	Texture Depth (mm) Erosion Index	≥ 1.2 ≤ 5
Wear	Initially	Texture Depth (mm) SRV	≥ 1.4 ≥ 65
	After 100 000 wheel passes	Texture Depth (mm) Erosion Index	≥ 1.1 ≤ 3
Binder Tensile Adhesion		Stress at –10 ± 2 °C	≥ 1.0 (N/mm^{-2})
Binder Tensile Adhesion		Stress at 20 ± 2 °C	≥ 0.5 (N/mm^{-2})

4 SUITABLE SITES FOR HFST

HFST is a surface application typically used in accident blackspots and high-risk locations to improve safety and reduce crashes. HFST provides a high level of skid resistance in comparison to traditional bituminous and concrete surfacings.

Each jurisdiction should have a skid resistance management policy that defines how Investigatory Levels are set for sites. High-risk locations are generally considered to be those requiring an Investigatory Level (IL) above 0.55 when measured by iSSAVe (Intelligent Safe Surface Assessment Vehicle).

High-risk locations may include:

- *approaches to major intersections*
- *approaches to schools or pedestrian crossings*
- *sites with gradients steeper than 10%, especially if other hazards are present*
- *curves with a radius greater than 500 m on dual carriageways or curves with a radius less than 500 m on single carriageways, particularly if there are risk factors that present a potential for loss of control such as an adverse camber or the geometry of the curve being potentially hazardous at higher traffic speeds.*

5 CRITERIA FOR HFST DEPENDING ON EXISTING SURFACING TYPE

Whilst a HFST can be applied to any road surface material, there is an increased risk of adhesive or cohesive failure with certain substrate types.

The substrate should be firm and sound. There should be no movement of the surface, and there should be no ravelling, crumbling, loose stones, patching, flushing, weeds or ingrained contamination. The pavement substrate should also be monolithic, that is composed of a single layer of asphalt or concrete. Element surfaces such as segmental paving and, to some extent, sprayed seals, slurry seals and cracked pavements are less than ideal, as the movement between the elemental joints will reflect through to the surface.

Road asset owners should ensure the suitability of any site earmarked for the application of a HFST. The performance warranty for a HFST may be void if it is applied to an unsuitable surfacing, or to pavements that may have structural defects or are likely to develop structural defects.

Whilst the risk of failure of a HFST is minimal if it is applied to a properly prepared surface by competent contractors, there are performance risks associated with the application of a HFST depending on the type of surfacing to which it is applied.

These risks are outlined in Table 3.

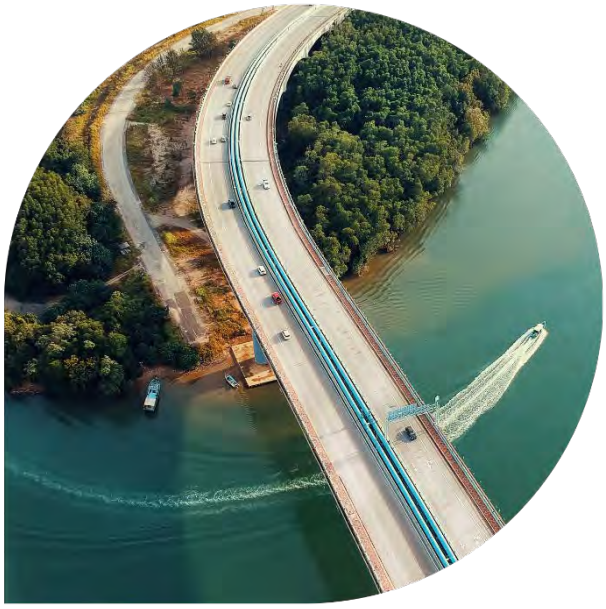
Table 3: Performance risks associated with the application of a HFST depending on the type of surfacing to which it is applied

MATERIAL	RISK
Dense-graded asphalt	1 – Minimal
Stone mastic asphalt	1
Concrete (correctly prepared)	1
Ultra-thin asphalt	2
Asphalt	3 – Moderate
Open-graded asphalt	3
Sprayed seal (PMB binder)	3
Concrete (unprepared)	4
Sprayed seal (bitumen binder)	4
Slurry surfacing	5 – High

Current pavement types that have been identified as being suitable for HFST are dense graded asphalt, stone mastic asphalt or a concrete surface that has been suitably prepared. These pavements have generally been designed with a high-strength matrix and, as such, will generally reduce the potential for cohesive material failure.

6 SPECIFICATION FOR HFST

HFST should comply with the *Model Specification for High Friction Surface Treatments* as per Appendix A. The model specification is intended to be used as a framework for the development of local government, state or national specifications.



Whilst at present there is no formal pre-qualification for products or contractors currently in place in Australia and New Zealand, it is critically important that material manufacturers and construction contractors have a full and detailed understanding of the specification, and what is required to achieve compliance.

The HFST specification, whilst prescriptive in some respects, remains primarily a performance-based specification with the onus for performance and compliance placed on the material manufacturer and the contractor.

In particular, contractors should be expected to provide documentation including, but not limited to the following:

1. Documented evidence of satisfactory performance in a heavy urban traffic environment over at least five years. The documentation may include references from clients, details of sites, and evidence of retention of texture, skid resistance and durability with time.
2. A Certificate of Compliance issued by the material manufacturer confirming that the proposed HFST, binder and aggregate is fit-for-purpose and, if installed by the contractor with due care and diligence in accordance with the manufacturer's work method statement, compliant with this specification.
3. A Warranty for a period no less than five years.

Although not a formal requirement under the specification, manufacturers are encouraged to have their HFST tested for advanced scuffing and wear in accordance with the UK TRL 176 Laboratory Assessment (Nicholls 1997). This will provide definitive evidence of performance, and confidence in the likely performance of the product for the contractor and client.

7 INFORMATION TO BE PROVIDED BY THE CLIENT

As part of any request for tender using HFST it is recommended that the contract documents should include the following information:

- *the installation should comply with the local jurisdiction specification, which should be based on the model specification (Appendix A)*
- *a clear site drawing indicating the area to be treated*
- *the overall quantities (m^2) to be applied*
- *the current traffic volumes and estimated traffic volumes for the next five years*
- *the type and age of the surfacing on which the HFST is to be installed*
- *the projected timing (summer/winter) of works during which the HFST may be applied*
- *specific traffic management restrictions or requirements*
- *other site-specific requirements that may be applicable.*

The documents should include sufficient detail to enable the scope of the works to be clearly identified.

In consideration of the works, clients should be aware that numerous factors will impact the prospective costing associated with HFSTs. A site risk assessment should be considered to determine proposed working times and what traffic management will be required.

For example, working under full road closures offers significant advantages in terms of speed of installation and safety and technically by potentially reducing the number of construction joints in the installation.

Where possible, day works are preferred as this will minimise cost and risk.

Clients should also be aware that variations to works, in particular a significant reduction in the size of the indicated site program, will increase the contractor's overhead costs. Accordingly, any significant changes post tender can lead to significant cost variations; contracts should make provision for variations costs under these circumstances.

A client checklist is provided in Appendix B.

8 PLANNING AND COORDINATION

Careful and detailed planning before work commences is an essential element to ensure that the HFST application is successful. It is in the interests of both the contractor and the client that the program of works flows smoothly.

It should be a condition of the quality assurance process that the contractor informs the customer in writing whether in their opinion, the surface is acceptable.

Where the contractor believes that a good-quality HFST installation cannot be achieved in accordance with the specification, then it is recommended that the areas of concern are identified in a Non-Conformance Report. The client may then choose to undertake remedial pavement repairs or, alternatively, the parties may mutually acknowledge that the installation of the HFST will not commence during the liability period.

Ultimately the suitability of the specification, design, plan and set out for HFST application rests with the client. The contractor cannot warrant the performance of any applied surfacing if the pavement surface has, or over time develops, structural defects resulting in substrate failure including, but not limited to, any form of deterioration or cohesive failure within the substrate. Similarly, performance cannot be warranted if the pavement surface is found to contain any contaminates which may be harmful to the adhesive or cohesive performance of the system and/or the substrate including, but not limited to, concrete curing agents and/or hydrocarbon contaminants such as oils and similar materials.

There should be close co-ordination between the contractor and the client at every stage of construction, commencing with a pre-works meeting, the purpose of which is to ensure that the contractor understands the way that the site works program will proceed.

9 OCCUPATIONAL HEALTH, SAFETY, AND ENVIRONMENT (OHSE)

OHSE issues should be addressed in accordance with the legislative requirements of the State or Territory in which the works are being undertaken.

All parties involved in the planning and execution of the works have a legal duty of care for the health and safety of both the operatives carrying out the works, and those who may come into contact with the operation whilst works are in progress and during aftercare.

The planning and organisation of OHSE issues commences as soon as a works program is envisaged. Site-specific risk assessments and Safe Work Method Statements (SWMS) should be prepared and used to identify control measures for both physical and chemical hazards.

The SWMS, and the measures contained within it, should be communicated to all involved in the project during the project induction procedure.

Account should also be taken of environmental factors including, but not limited to, fumes, noise and dust. Disposal of waste and protection from spillage and contamination are other considerations.

10 PLANNING THE EXECUTION OF THE WORK

Poor planning can result in low daily output, increased costs and public criticism. Proper risk assessments undertaken in advance of the works enable supervisory staff to consider all aspects of the application process. This is particularly critical on complex intersections where there is a requirement for lane closures in busy urban areas to ensure that maximum output is achieved with minimal disruption to traffic flow.

In addition to compiling the site information, the contractor responsible for the application of the HFST should decide on how the HFST is to be applied in accordance with the specification.

Consideration also needs to be taken of; the area to be surfaced, existing site conditions, traffic flow, application period and the time of the year the works are to take place.

The overall completed site should have minimal joints and provide for a uniform surface texture, skid resistance and appearance which is free of surface blemishes and any discernible faults.

11 TRAFFIC MANAGEMENT REQUIREMENTS

Traffic management should be managed by suitably qualified contractors in accordance with the regulations stipulated by the local road agency.

12 SURFACE PREPARATION

In all cases due consideration should be paid to the installation method statement. It is essential that the substrate to be treated is in sound condition to maximise the service life of the HFST.

The cleanliness of the existing road surface is critical to the ability of the HFST to adhere to the existing surfacing. The contractor should ensure that the road surface is clean and dry, free from ice, frost, loose aggregate, embedded topsoil, vegetation, oil, grease, any other loose material which is likely to impact on the adhesion of the HFST to the existing surfaced.

The type of HFST systems that are available can influence how quickly freshly-laid asphalt can be treated. The time delay between laying new asphalt and installing a HFST is also influenced by the porosity of the surface course as this influences the rate of volatile loss from the newly-installed asphalt layer. It may be possible to lay some HFST systems onto new asphalt without significant delay depending on the recommendations of the manufacturer.

The time between completion of the asphalt surfacing and the application of HFST can vary between less than 24 hours, and up to 28 days. Minimum time intervals should be stated on manufacturer's data sheets, and these should be strictly followed.

Concrete surfaces present a different challenge, and failure to correctly prepare a concrete surface prior to the application of a HFST can result in catastrophic adhesion failure.

New concrete should be water cured for at least 28 days, well compacted and finished, preferably by power-floating or trowelling to give a dense and smooth finish.

Old concrete should be structurally sound, with all loose and deteriorated areas replaced and spalled areas repaired. Any existing coatings may have to be removed.

The concrete substrate should have a moisture content no greater than 5% by volume. The surface should be clean, free from dust, oil, and grease, or other contaminants that may impair the adhesion of the HFST system.

All concrete surfaces should be mechanically abraded by captive shot blasting, diamond grinding, scarification, hydro blasting or other approved methods. If required, they should be suitably primed in accordance with manufacturer's instructions.

Road surface and ambient temperatures should be measured. HFST should not be carried out if the road surface temperature does not comply with the range provided in the method statement for the system.

13 HFST CONSTITUENTS

13.1 BINDER

The HFST specification allows many types of polymer binders to be used. However, it is critically important to understand that some HFST binders appear to perform better than others, particularly given the various asphalt mix designs and climate conditions that exist in Australia and New Zealand.

Project engineers should follow due diligence and obtain documented evidence of satisfactory performance of HFST in a heavy urban traffic environment for at least five years. The documentation may include references from clients, details of sites with successful use of HFST, and evidence of variations in texture skid resistance and durability over time.

Binders proposed for use as the basis of a HFST should:

1. be a thermosetting, two or more component, cross-linking, flexible, polymer resin capable of permanently adhering to the road surface and holding aggregate in position under heavy vehicle trafficking without the need for encapsulation.
2. be resistant to fuel and oils spills
3. be free from flammable solvents, lead and other heavy metals
4. be resistant to structural degradation by ultra-violet (UV) light or sunlight
5. not emit offensive odours during installation or after curing.
6. demonstrate the minimum film properties as defined in Table 4.

Table 4: Test parameters

TEST	PARAMETER	TEST METHOD (OR APPROVED EQUIVALENT)	REQUIREMENT
Binder elongation at break	7 days @ 23 °C	ASTM D638-03	≥ 30%
Binder tensile strength	7 days @ 23 °C	ASTM D638-03	≤ 10.5 N/mm²

Thermoplastics, bitumen emulsions and/or polymer modified derivatives, along with paints of any description, are not suitable for use as a HFST under these guidelines.

13.2 AGGREGATE

The calcined bauxite aggregate to be used in Type 1 HFST applications should meet the requirements shown in Table 5.

Calcined bauxite of nominal 1-3 mm grading is the only type of aggregate with a proven history in HFST, and suppliers of this material should provide evidence as required that their materials comply with the specification in Table 5.

Table 5: Specification for properties of calcined bauxite

PHYSICAL PROPERTY	LIMITS	TEST METHOD
Polished Stone Value	70+	BS EN 1097-8:2009
Abrasion value	≤ 4	BS EN 1097-8:2009 Annex A
Particle density	≥ 2.8	BS EN 1097-6:2000
Moisture content	≤ 0.5%	BS EN 1097-6:2000
Particle angularity	Blocked shape	Visual Assessment
Grading	% passing	
4.00 mm	100%	
3.35 mm	≥ 95%	BS EN 933-1:1997
1.18 mm	≤ 5.0%	
0.60 mm	≤ 0.5%	
Chemical Composition	Weight %	
Al2O3	≥ 82.0%	
Fe2O3	≤ 4.5%	XRF Spectrometry
SiO2	≤ 12.5%	
K2O+Na2O	≤ 0.5%	
TiO2	≤ 4.5%	

14 INSTALLATION PROCESS

14.1 GENERAL

It is the responsibility of the manufacturer and the contractor to ensure that the application of the materials is in accordance with their installation method statements and the specification.

A copy of the manufacture's installation method statement should be available on every site for review and audit as required.

14.2 PRE-WORKS CALIBRATION

The contractor should have all necessary calibrated measuring equipment on site for correct batching of the constituents, and all relevant certificates.

14.3 APPLICATION OF BINDER

The binder should be spread to provide a uniform coverage and thickness over the site and in accordance with the manufacturer's recommendations. The spread rate for each lot of material should be determined by mass or volume divided by the area, and the results recorded. All application rates should be recorded and kept by the contractor as part of their Quality Assurance (QA) procedures.

14.4 APPLICATION OF CALCINED BAUXITE

The aggregate should be spread to provide a uniform thickness over the site ensuring the binder is fully covered and impregnated. No rolling of the aggregate should be permitted, and excess aggregate should not be removed until the binder has reached a tack-free cure.

No encapsulation of the aggregate should be permitted.

14.5 CLEAN-UP

All excess material should be removed from the site and disposed in accordance with EPA requirements. All masking should be removed prior to opening the site to traffic.

Excess aggregate should be removed from the finished surface, roadway, kerb and channel, driveways, surrounding footpaths and any adjacent areas prior to opening the site to traffic.

14.6 AFTER-CARE

All aggregate material which becomes loose after the initial clean-up should be removed within 48 hours after opening to trafficking.

15 INSTALLATION PROCESS

The defects liability period for the applied surfacing should be five years, during which time the contractor should be responsible for meeting the required performance criteria shown in Table 6 from the time of placement until the end of the defects liability period.

Table 6: Required performance criteria for a five-year defects warranty

PARAMETER	PERFORMANCE CRITERIA
Skid resistance - Sideways coefficient of friction (SFC), or - Skid resistance value (SRV)	 ≥ 0.65 ≥ 65
Mean texture depth in wheelpaths (mm)	≥ 1.0
Loss of surface area	< 1%

If the client is aware, or becomes aware, or ought reasonably to be aware of any deterioration that may give rise to a defect liability, then the client should promptly report it to the contractor within the designated defects liability period.

Once aware of a suspected defect, the contractor should carry out any works necessary to rectify the defect and repair all surface defects, including loss of aggregate, flushing, and delamination from the existing surface.

Areas of aggregate loss or delamination less than 0.01 m^2 are not required to be repaired unless the total of defective areas exceeds 1% of the total area. Areas of defect should be agreed with the client and a rectification plan should be enacted.

The contractor is not usually responsible for defects caused by either settlement or failure of the existing pavement (including, but not limited to, cohesive failure within the existing pavement), or for damage (including gouging and vehicle fire) and repairs to the surface caused by traffic incidents.

The contractor is also not usually responsible for the general day-to-day maintenance of the HFST or for accelerated wear or defects caused by any failure of the client to properly maintain the site – which may in turn mitigate the contractor's responsibilities with respect to defects.

16 QUALITY ASSURANCE (QA)

As a primary obligation, the contractor should be committed to meeting the needs and expectations of the client through the capable implementation of tried and proven Quality Management Systems (MS). This is achieved by:

- *complying with statutory obligations, standards, specifications and codes of practice relevant to quality management*
- *maintaining, monitoring, reviewing, auditing and continually improving their quality management systems in line with the requirements of AS/NZS ISO 9001*
- *providing sufficient and suitable resources to implement and maintain a suitably-designed quality management system*
- *engaging suitably qualified, skilled, and experienced people*
- *educating and training to continually improve skills, including awareness and knowledge of quality issues and practices*
- *identifying, reporting, investigating and resolving all non-conformances and acting to prevent recurrence*
- *establishing, reviewing and communicating performance measures and acting to improve outcomes*
- *monitoring and evaluating the quality performance of consultants, subcontractors and suppliers and implementing effective communication with them on quality and compliance issues.*

17 REFERENCES

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Test Methods

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Standards

AS/NZS ISO 9001:2016, Quality management systems – requirements.

ASTM D638-03, Standard test method for tensile properties of plastics.

BS 7941-1:2006, Methods for measuring the skid resistance of pavement surfaces: sideway-force coefficient routine investigation machine.

BS EN 1097-6:2000, Tests for mechanical and physical properties of aggregates: determination of particle density and water absorption.

BS EN 1097-8:2009, Tests for mechanical and physical properties of aggregates: determination of the polished stone value.

BS EN 933-1:1997, Tests for geometrical properties of aggregates: determination of particle size distribution – sieving method.

APPENDIX A MODEL SPECIFICATION

A.1 GENERAL

This section covers the requirements for the supply and placement of HFSTs. They shall not be classified as line marking but rather as a high friction wearing course to be installed by an experienced and competent civil-orientated contractor.

The HFST must:

1. provide excellent skid resistance, and texture depth as well as resistance to wear, ravelling and delamination for at least 5 years
2. be resistant to fuel and oils spills from traffic, able to withstand traffic stresses without damage other than that associated with general wear and tear
3. be able to be swept using a mechanical broom and cleaned with high-pressure water equipment without damage.
5. not emit offensive odours during installation or after curing.
6. demonstrate the minimum film properties as defined in Table A 1.

Only products with satisfactory documented evidence will be considered for the works. However, acceptance of the documented evidence and acceptance of the proposed HFST does not guarantee the performance of the HFST. It also does not relieve the contractor from any performance requirements.

Table A 1: Binder test parameters

TEST	PARAMETER	TEST METHOD (OR APPROVED EQUIVALENT)	REQUIREMENT
Binder elongation at break	7 days @ 23 °C	ASTM D638-03	≥ 30%
Binder tensile strength	7 days @ 23 °C	ASTM D638-03	≤ 10.5 N/mm²

Thermoplastics, rosen esters, bitumen emulsions and/or polymer modified derivatives, along with paint of any description shall not be permitted for use.

A.2 DEFINITIONS

A Glossary of Terms is provided in Appendix C.

A.3 MATERIALS

A.3.1 BINDER

Binder used for HFST shall:

1. be a thermosetting, two or more component, cross linking, flexible, polymer resin capable of permanently adhering to the road surface and holding aggregate in position under heavy vehicle trafficking without the need for encapsulation
2. be resistant to fuel and oils spills from traffic
3. be free from flammable solvents, lead and other heavy metals
4. be resistant to structural degradation by ultra-violet (UV) light or sunlight

A.3.2 AGGREGATE

Aggregate used for HFST shall conform to the properties listed in Table A 2, and additionally:

1. be calcined bauxite
2. unless otherwise specified, be nominally grey in colour
3. be clean, free from dirt, clay and organic matter.

Table A 2: Specification for the Properties of Calcined Bauxite

PHYSICAL PROPERTY	LIMITS	TEST METHOD
Polished Stone Value	70+	BS EN 1097-8:2009
Abrasion value	≤ 4	BS EN 1097-8:2009 Annex A
Particle density	≥ 2.8	BS EN 1097-6:2000
Moisture content	≤ 0.5%	BS EN 1097-6:2000
Particle angularity	Blocked shape	Visual Assessment
Grading	% passing	
4.00 mm	100%	
3.35 mm	≥ 95%	BS EN 933-1:1997
1.18 mm	≤ 5.0%	
0.60 mm	≤ 0.5%	
Chemical Composition	Weight %	
Al2O3	≥ 82.0%	
Fe2O3	≤ 4.5%	XRF Spectrometry
SiO2	≤ 12.5%	
K2O+Na2O	≤ 0.5%	
TiO2	≤ 4.5%	

A.3.3 COMPLIANCE

The tenderer shall as part of their tender submission supply the following documentation in respect of the proposed HFST:

1. A current Technical Data Sheet or test certification detailing:
   (a) product name and manufacturer's and/or supplier's details
   (b) type and composition of binder used
   (c) type and source of the calcined bauxite used
   (d) PSV and chemical composition of calcined bauxite being used
   (e) supplier's detailed work method statement and instructions for surface preparation of concrete and/or asphalt as may be applicable
   (f) supplier's detailed work method statement demonstrating the application methodology of the HFST.
2. Documented evidence of satisfactory performance over at least five years for the HFST in a heavy urban traffic environment within Australia. The documentation may include references from clients, details of sites with HFST, evidence of retention of texture, skid resistance and durability over time.
3. A Certificate of Compliance document from the material supplier detailing that the proposed HFST, binder and aggregate is fit-for-purpose and, if installed by the contractor with due care and diligence in accordance with the supplier's work method statement will be compliant with this specification.
4. Confirmation that a warranty can be provided for the HFST based on the condition of the existing pavement.
5. Written confirmation from the HFST supplier confirming the contractor is trained and internally accredited in the placement of their HFST.
6. a 100 mm x 100 mm finished sample of HFST that is representative of the final surface finish that the contractor proposed to install.

A.4 SITE PREPARATION

All loose material, grit, stones, vegetative matter, and rubbish shall be removed from the area of works prior to placement of the HFST.

All pavements shall be cleaned and prepared in strict accordance with the supplier's work method statements. Cleaning and preparation shall not cause structural damage to the pavement. All cleaning agents and collected material shall be removed from the site and disposed in accordance with local Environment Protection Authority (EPA) requirements for the type of waste generated.

Unless the existing pavement markings at the site are to be removed then all exiting markings shall be masked to ensure the HFST is not applied to the markings. All raised reflective pavement markers (RRPMs) may either be removed from the area of works prior to any HFST being placed, or masked to ensure the HFST is not applied to the RRPMs. All masking shall be removed prior to opening the site to traffic.

Service pits and valve covers, and drainage grates and frames shall also be masked. When masking, contractors shall ensure that all lifting mechanisms and joins between the lid and frame are protected such that the HFST does not impede lifting and replacing lids.

A.5 PLACEMENT

HFSTs shall be applied to produce a visually uniform textured surface. The edges of the work shall provide a neat and clean line onto the adjacent surface.

A.5.1 PRIMING MATERIALS

Priming materials where used shall be applied uniformly over the site. The application rate for each lot of material shall be determined by mass or volume divided by the area and result recorded. All application rates for the work shall be recorded and kept by the contractor as part of their QA procedures.

A.5.2 BINDER

The binder shall be spread to provide a uniform coverage and thickness over the site and in accordance with the manufacturer's recommendations.

The spread rate for each lot of material shall be determined by mass or volume divided by the area, and the result recorded. All application rates for the work shall be recorded and kept by the contractor as part of their QA procedures.

A.5.3 AGGREGATE

Aggregate shall be spread to provide a uniform thickness over the site ensuring the binder is fully covered and impregnated. No rolling of the aggregate shall be permitted, and excess aggregate shall not be removed until the binder has reached a tack-free cure.

The spread rate for each lot of material shall be determined by mass or volume divided by the area, and the result recorded. All application rates for the work shall recorded and kept by the contractor as part of their QA Procedure.

No encapsulation of the aggregate shall be permitted, and no lock coat shall be applied to the aggregate after application.

A.5.4 CLEAN UP

All excess material shall be removed from the site and disposed in accordance with EPA requirements. All masking shall be removed prior to opening the site to traffic. Excess aggregate shall be removed from the finished surface prior to opening the site to traffic. Excess aggregate shall be removed from the roadway, kerb and channel, driveways, footpaths and any adjacent areas prior to opening to traffic. All aggregate material which becomes loose after the initial clean-up shall be removed within 48 hours after opening to trafficking.

A.6 FINISHED SURFACE PROPERTIES

Notwithstanding that the HFST will weather and become contaminated with road grime and other contaminates, for the duration of the defects liability period the applied HFST shall:

1. be of a consistent and uniform finish with no loss of aggregate or surface delamination exceeding 0.01%, unless the total of defective areas exceeds 1% of the total area
2. provide for a minimum mean average Texture Depth of 1.0 mm in the wheelpaths.
3. provide for a minimum Sideways Coefficient of friction (SFC) of 0.65 measured by iSSAVe, or minimum Skid Resistance Value (SRV) of 65 when measured by British Pendulum, when any time during the defects liability period.

A.7 WARRANTY

Except where the Contractor accepts a tender that does not include a warranty for the HFST, the warranty period for the applied surfacing shall be five years, during which time the contractor shall be responsible for any defect in performance as detailed in Appendix A.6 from the time of placement, until the end of the defects liability period.

It shall be the client's responsibility to monitor the performance of the HFST during the defects liability period. If the client is aware, or becomes aware, or ought reasonably to be aware of any deterioration that may give rise to a defect liability under Appendix A.6, the client must promptly report it to the contractor within the designated defects liability period.

Once aware of a suspected defect, the contractor shall carry out any works necessary to rectify the defect and repair all surface defects, including loss of aggregate, loss of skid resistance, loss of surface texture, and delamination from the existing surface.

Areas of aggregate loss or surface delamination less than 0.01 m^2 are not required to be repaired, unless the total of defective areas exceeds 1% of the total area. Areas of defect shall be agreed with the client's superintendent.

The contractor is not responsible for defects caused by either settlement or failure of the existing pavement (including, but not limited to, cohesive failure within the existing pavement), or for damage (including gouging and vehicle fire) and repairs to the surface caused by traffic incidents.

A.8 WARRANTY AND ACCEPTANCE OF WORKS

Acceptance of work and materials shall be based on testing, inspection and certification of the work or material in lots.

Within 14 days of initial placement of each test lot, the contractor shall arrange for each test lot to be inspected by the client who, once satisfied by a visual assessment, will provide written acknowledgement to the contractor of practical completion, such acknowledgement will not be unreasonably withheld.

The contractor shall then submit to the client with any payment claim a Certificate of Conformance for such test lot.

This Certificate of Conformance shall be issued to the client and shall be endorsed by the contractor and by the supplier, where applicable, detailing:

1. the date of HFST installation
2. the date of practical completion issued by the client
3. the name of the HFST material supplier and the installation contractor
4. the batch numbers of the HFST materials
5. written acknowledgment that the HFST materials are compliant with this specification
6. the HFST has been installed in accordance with the supplier's work method statement
7. the HFST is representative of the sample provided in accordance with Appendix A.3.3.

Any HFST that fails to meet the minimum compliance or defects warranty requirements shall be rectified at the expense of the contractor and the use of the supplier's materials and/or the installation contractor may be suspended until such rectification is undertaken.

APPENDIX B CLIENT CHECK LIST

Prior to Tender or RFQ:

- *Has the need for a HFST been determined based upon the jurisdictions skid policy?*
- *Have the number of commercial vehicles or overall traffic volume been accurately determined?*
- *Has the existing road surface been inspected and found to be suitable for HFST?*
- *If pavement defects are present, are they to be rectified and, if so, how?*
- *Does any line-marking or raised reflective pavement markings or any existing HFST need to be removed as part of the works?*
- *Have traffic management requirements been assessed from a risk analysis perspective?*
- *Are the works to be undertaken during the day or at night, weekends or week days?*
- *Has the site been fully scoped in terms of the set out and required HFST surface area?*
- *Is a pre-tender site meeting required?*

Post-tender or RFQ:

- *Has all relevant technical data and information from the contractor, supplier and manufacturer been obtained to ensure compliance with the specification?*
- *Has due diligence been conducted on this information?*
- *Does the contractor have the experience and resources?*
- *Is the contractor accredited in writing by the manufacturer or supplier?*
- *Do the proposed products, binder and calcined bauxite meet all specification requirements?*
- *Are there any ambiguities that need to be resolved?*
- *Has a post-tender meeting and site inspection been arranged with the preferred contractor?*

During HFST Application:

- *Is traffic management set up to the required standard?*
- *Have the on-site parameters of the works been clearly marked out and defined?*
- *Is the contractor following their SWMS and installation procedures as issued by the manufacturer?*

Post-HFST Application:

- *Has the site been inspected for visual uniformity?*
- *Has the site been completed as per the designated site drawings?*
- *Has the contractor programmed after-care sweeping to remove any aggregate shedding?*
- *Has practical completion been issued?*
- *Has the contractor provided the certificate of conformance?*
- *Has the certificate of conformance been endorsed by the HFST supplier?*

APPENDIX C GLOSSARY OF TERMS

ADEPT	Association of Directors of Environment, Economy, Planning and Transport
Adhesion	The property by which a binder sticks to the surface of a solid body, e.g. the road or aggregate
Aggregate	graded calcined bauxite particles that are applied to the binder, to provide a textured highly skid resistant surface
BBA	British Board of Agrément – a certification body which operates the HAPAS scheme for HFS
Binder	The thermosetting resin used to bond the calcined bauxite aggregate to the existing road surface
Bond	The adhesion between the binder and either the road surface or the applied calcined bauxite
Calcined bauxite	A manufactured aggregate derived from calcining bauxite clay in a kiln at high temperatures to produce a very hard aggregate with exceptional skid resistance properties
Client	The party who awards a contract for placing HFST
Cure	The chemical reaction between liquid binder constituents that results in a solid binder being formed
Defects liability period	Five years from the date of placement
Delamination	The failure of the binder and aggregate to adhere to the existing pavement surface
Encapsulation	To enclose or cover the aggregate by pre-mixing it with a binder prior to, or during, application. It also includes covering the aggregate, once placed onto the binder, with a lock coat or an additional layer of binder or protective sealer of any description
HAPAS	Highway Authorities Product Approval Scheme for certifying the performance in situ of HFS systems
High-friction surface treatment (HFST)	a binder applied to the existing road surface and impregnated with a highly-polished stone aggregate to provide a durable, high friction, skid resistant veneer surface coating.
Lock coat	Any paint, sealer, protective coating or additional layer of binder that is applied over the aggregate surface once it is imbedded in the base binder resulting in the encapsulation of the aggregate
Polished stone value (PSV)	A measure of an aggregate's resistance to polishing under traffic in accordance with BS EN 1097-8: 2009 or equivalent
Priming material	Any thermosetting binder or variant thereof designed to promote and improve the adhesion of the primary binder application to the existing roadway
Quality assurance (QA) (in the context of HFST)	Systematic monitoring and evaluation of the various aspects of a high friction surfacing operation to ensure that minimum standards of quality are being attained by the production process
Resin	A liquid polymer used as the basis of the adhesive binder

iSSAVe	A measure of the skid resistance of a road surfacing under wet conditions using an Intelligent Safe Surface Assessment Vehicle
Skid resistance	The frictional forces between tyre and pavement surface which are available to oppose a vehicle skidding
Supplier	The corporate entity, company, sole trader or individual (other than the installing contractor) responsible for the manufacture, distribution and sale of the HFST in the public domain
Surface texture	The average height of aggregate particles above the level of the binder
Test lot	A single batch or area of like work which has been constructed under uniform conditions. It is essentially homogeneous with respect to material and appearance and shall be the lesser of either one day's production or each 300 m^2
Texture depth	A term used to denote the measure of projection of aggregates in a surface course
Thermoplastic	The property of material by which their viscosity changes in relation to temperature change
Thermosetting	A material formed by an irreversible chemical reaction of two or more components which renders it resistant to temperature variations

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