SPECIFICATION OF CONCRETE FLAG PAVING

Published by Interpave
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Introduction

This document is intended to provide guidance with the specification of concrete flag paved surfaces, including model specification clauses where appropriate. It is intended only for the use of experienced paving designers with a full understanding of flag paving technology.

Manual for Highway Works

All the requirements of the Manual for Highway Works Series 1100 shall apply except where the requirements of this series of special clauses supercede them. In particular, the following should be noted:

Precast Concrete Flags and Natural Stone Slabs

1 (11/04) Precast concrete flags shall conform to BS EN 1339. Natural stone slabs shall conform to BS EN 1341. Type designations, thickness and performances and classes shall be as described in Appendix 11/1.

2 (11/04) Precast concrete flags and natural stone slabs shall be laid in accordance with BS 7533-4, to the required cross falls with a bond as described in Appendix 11/1 and with longitudinal joints at right angles to the kerb. Flags and natural stone slabs shall be bedded on a layer of mortar not less than 10mm and not more than 40mm thick. Where permitted in Appendix 11/1, flags and natural stone slabs 450mm x 450mm and smaller may be laid on a layer of sand conforming to BS EN 12620 designation 0/4mm, 25mm ± 5mm thick. Joints to be filled with sand, conforming to BS EN 12620 designation 0/2.

It should be noted that flags on a mortar bed require a mortar joint.

3 (05/01) On circular work where the radius is 12m or less, all flags and natural stone slabs shall be radially cut on both edges to the required line.

4 (11/04) The laying course shall be laid on sub-base composed of one of the materials complying with Clause 803, 804, 805, 806, 821, 822 or 823, laid and compacted to Clause 802 or 813, as appropriate and to the thickness described in Appendix 11/1.

Additional Interpave Clauses and Notes

NG1. Precast concrete paving flags

1.1 Precast concrete paving flags shall comply with the requirements of BS EN 1339.

1.2 Precast concrete paving flags shall be laid to the requirements of BS 7533:Part 4.

1.3 Precast concrete paving flag shall have an overall length that does not exceed 1m and an overall length, which when divided by its thickness, is greater than four.

1.4 Table 1 provides guidance on use and properties of paving flags for different applications.

Table 1. General guidance on usage

Application	Minimum thickness mm	Strength kN	Abrasion mm	Slip/skid	Freeze /Thaw kg/m²
Domestic paths and patios	30	3.0	No performance required	40 min	No performance required
Pedestrian areas only, very occasional vehicles	50	4.8			
Footways, crossings, car parks & lightly trafficked areas	60*	10.8**	≤ 26	40 min	≤ 1.0
Residential roads with 25 commercial vehicles	60*	14.4**	≤ 20	40 min	≤ 1.0
Pedestrian precinct with vehicle overrun	60*				
Factory floors, industrial	60*				
* depending on plan size		** depending on thickness			

NG2. Tolerance of surface levels of different layers of the pavement

2.1 The recommended permissible deviation from the design level of the different layers are:

Sub-base	+5mm, – 10mm
Road base	+5mm, – 10mm
Laying course	–5mm, +10mm
Surface course	±6mm

2.2 The recommended surface regularity of the surface course are:

Flatness of pavement:	3mm under 3m straight edge when laid
Difference in levels at the joints of adjacent paving units:	2mm

When laying riven faced flags the above tolerances do not apply.

2.3 Where flags are laid abutting drainage channels or fittings, the surface of the flags shall be between 3mm and 6mm above the channel or fitting.

2.4 Where flags are laid abutting gullies, the surface of the flags shall be between 3mm and 6mm above the gully grating and frame.

NG3. Preparation of subgrade for pavements

The preparation shall comply with the Manual for Highway Works.

3.1 The area to be paved shall be excavated to formation level and any unsuitable material removed from the subgrade and replaced with properly compacted material, with similar properties to the adjacent sound subgrade material.

3.2 Any sub-soil drainage located beneath the pavement shall be completed in conjunction with subgrade preparation, before commencement of the sub-layer construction.

3.3 All trenches within the pavement area shall be backfilled with suitable material in layers, with each layer compacted before the next is placed and its compaction shall not be inferior to the surrounding subgrade. Power rammers shall not be used within 300mm of any drain or service.

3.4 The surface level of the subgrade shall not deviate from the design level.

NG4. Sub-layers for pavements

General

The subgrade, sub-base and roadbase, if present, should be presented such that:

a) the surface levels of the sub-base and roadbase are within tolerances

b) the longitudinal and cross falls of the completed paving are introduced at the subgrade level

c) the surface of the sub-base and roadbase is tight and dense to prevent laying course migration.

4.1 Where sub-base and roadbase contains cement and is not covered by other materials within 2 hours, it should be protected from moisture loss.

4.2 When sub-base and roadbase contain cement allow this layer to cure for a minimum 40 hours after laying the surface course when compacting with a pavior's maul, or 72 hours when compacting with a plate vibrator.

4.3 The sub-layer material shall consist of one or other of the materials and shall comply with the relevant clauses from the Manual for Highway Works.

4.4 Any drainage provided within the sub-layer, shall be completed in conjunction with the sub-layer construction before the laying course is placed. Drainage inlets shall be protected with filter fabrics to prevent ingress of laying course material.

4.5 The sub-layer material shall be placed and compacted in accordance with the Manual for Highway Works.

4.6 The finished sub-layer shall have, immediately before overlaying, a close-textured surface, be free from compaction planes, ridges, cracks or loose material and show no movement under the compaction plant.

4.7 The surface levels for each layer shall not deviate from the design level clause 2.1.

4.7 Each layer of concrete, cement or bituminous bound material shall be fully compacted to comply with the relevant clauses from the Manual for Highway Works.

NG5. Preparation of existing bases as a sub-layer

Note: Where precast concrete products are to be laid over existing roads or similar types of construction, corrections to levels may be required.

5.1 Ensure existing drainage will continue to function after any adjustments to levels. New drainage shall be installed as necessary, in accordance with Manual for Highway Works.

5.2 Any excess materials shall be removed, using a planing process, to allow installation of the required laying course thickness.

5.3 Levels shall be built up using suitable material complying with, laid and compacted in accordance with Clause 3.

5.4 The surface levels for each layer shall not deviate from the design level (refer to Clause 2.1).

NG6. Restraint

6.1 Edge restraints should be installed before laying course and paving units laid.

6.2 Restraint shall be sufficiently robust to withstand override by any anticipated traffic.

6.3 The edge restraint should present a vertical face down to the level of the underside of the laying course.

6.3 Intermediate restraint may be needed in certain applications normally between junctions of different materials.

6.4 Temporary restraints might be needed to prevent paving units moving during construction or in areas that cannot be completed for some time.

6.5 Edge restraints shall be provided around all areas of paving.

6.6 Edge restraints may be formed by existing structures, kerbs, channels, edgings, blocks set on concrete, etc. Edge restraints shall be capable of preventing the loss of laying course sand, the sideways movement of flags, and of supporting anticipated traffic loads.

NG7. Laying course material

7.1 The selection of laying course material and bedding method is determined by the application given in Table 2.

Table 2. Application Categories

Site category	Standard axles per day	Typical applications
	> 60	Adopted highways and commercial developments used by a high number of commercial
II	≤60	Adopted highways and other roads used by a moderate number of commercial vehicles. Petrol station forecourts. Pedestrian projects subjected to regular overrun of commercial vehicles.
III	≤5	Adopted highways and other roads used by a low number of commercial vehicles, e.g. cul-de-sac on a housing development. Pedestrian projects subjected to occasional overrun of commercial vehicles Car parks receiving occasional commercial vehicular traffic. Footways overridden by commercial vehicular traffic.
IV	0	Car parks receiving no commercial vehicular traffic. Footways subjected to domestic vehicular crossover private drives, paths, patios, hard landscaping. Areas receiving pedestrian traffic only, e.g. school playgrounds.

7.2 Bound construction – laying paving units on mortar for all site categories I to IV, the bedding mortar shall have the properties given in Table 3:

Table 3. Properties of bedding mortar

Properties	Requirements
Minimum compressive strength A)	30 MPa
Minimum adhesive strength B)	2 MPa
Modulus of elasticity C)	(18 000 ± 3 500) MPa
Minimum density A)	2 000 kg/m^3
Maximum shrinkage D)	0.15%
A) Measured in accordance with BS 4551-1. B) Measured in accordance with DIN 18555-11. C) Measured in accordance with DIN 18555-4. D) Measured in accordance with BS 812-120.	

7.3 Bound construction – laying paving units on mortar in site category IV only, the laying course material should consist of a workable mix 1:3 cement-sand mortar using fine aggregate conforming to BS EN 12620 GF85 0/4.

7.4 Unbound construction – laying paving units on an aggregate laying course in site categories II, III and IV, the laying course material grading should conform to BS EN 12620 GF 85 0/4 MP fine.

NG8. Jointing material

8.1 Bound construction – laying paving units on mortar for all site categories, the jointing mortar shall have the properties given in Table 4:

Table 4. Properties of jointing material

Properties	Requirements
Minimum compressive strength A)	40 MPa
Minimum adhesive strength B)	1.5MPa
Modulus of elasticity C)	(20 000 ± 4 000) MPa
Minimum density A)	2 000 kg/m^3
Maximum shrinkage D)	0.15%
A) Measured in accordance with BS 4551-1. B) Measured in accordance with DIN 18555-11. C) Measured in accordance with DIN 18555-4. D) Measured in accordance with BS 812-120.	

8.2 Bound construction – laying paving units on mortar in site category IV, the jointing material should consist of a workable mix 1:4 cement-sand mortar using fine aggregate conforming to BS EN 12620 GF85 0/1.

8.4 Unbound construction – laying paving units on an aggregate laying course in site categories II, III and IV, the jointing material grading should conform to BS EN 12620 GF 85 0/4.

NG9. Preparation of laying course

9.1 Before commencement of the flag laying, the preceding work i.e. base construction, edge restraints, features and penetrations within the pavement such as drainage channels, inspection pits etc. shall be checked to ensure they are in compliance with the contract requirements. Particular attention shall be paid to the base levels and tolerances to ensure that when the flag layer is constructed to overall surface levels and tolerances are achievable.

Any non-conformances in the preceding works shall be corrected before the commencing of the flag layer construction.

The construction of the flag paving layer shall be laid by an Interlay member.

9.2 The surface of the cement bound base should be swept and washed clean removing dust, loose material and debris.

9.2 Bound construction – laying paving units on mortar for all site categories, the mortar with slump 150mm is spread out over the surface to a depth of approximately 30mm thick.

9.3 Bound construction – laying paving units on mortar in site category IV, the mortar shall be spread out over the base to give a compacted thickness between 15mm and 25mm after bedding the flags. Any mortar that has begun to set should be discarded.

9.4 Unbound construction – laying paving units on an aggregate laying course in site categories II, III and IV, the laying course thickness after compaction of the surface should be 25mm. The laying course material shall be prepared by one of the following methods:

(i) Compaction of laying course: spread out the laying course material in one layer, to a depth sufficient to give the required compacted nominal thickness and compact with a vibrating plate compactor. Level the surface by screeding.

(ii) Uncompacted laying course: spread out loose laying course material in a uniform layer. Screed the material to a depth sufficient to give the required compacted nominal thickness after compaction of the material and flags.

NG10. Laying pattern

10.1 For areas subjected to vehicular traffic, the most effective laying pattern is either one third or half bonded.

NG11 Laying paving units

11.1 Concrete paving flags should be placed, either mechanically or by hand, on the prepared laying course in the nominated pattern.

11.2 Use string lines to check alignment of paving flags. Joint (bond) lines for all paving shall not deviate more than 3mm.

11.3 Bound construction – laying paving units on mortar for all site categories, the back of the flags should be primed using suitable slurry prior to laying directly onto the bedding material with joint widths of 6mm to 10mm. Working off the base, the paving flags are laid to line and level and compacted down using a pavior's maul. After the initial set of the laying course mortar, the whole area should be wetted and the jointing material in slurry form should be either spread over the entire surface and moved to the open joints or gunned in or poured in by watering can.

11.4 Bound construction – laying paving units on mortar in site category IV, the workable mortar is spread out over the area to be laid, working off the base the paving flags are laid to line and level and compacted down using a pavior's maul. The joint width should typically be within the range 6mm to 10mm. The paving flags should have their joints to the full depth or 2mm to 3mm below the upper edge. The mortar should be firmly pressed into the joints with a trowel or suitable rod, or spread on the side of the laid paving offer the next flag to this, striking off surplus mortar. Clean off any mortar on the flag surface immediately to avoid staining.

11.5 Unbound construction – laying paving units on an aggregate laying course in site categories II, III and IV using one of the following methods of screeding the laying course should be used for concrete paving:

a) Spread the material in one layer and compact this layer using a plate compactor and then the top 10mm should be loosened using a rake.

b) Alternatively, 25mm of laying course material should be screeded out, compacted and then a further 10mm of loose material screeded out.

Working off the previously laid flags, each flag is laid on the laying course with a 3mm to 5mm joint width and cutting flags, if necessary. Jointing material is swept over the area and into the joints. The flags are compacted into the laying course, using a plate vibrator, making two or more passes. No area should be left uncompacted at the completion of a day's work.

11.6 Use string-lines to check alignment of paving units.

11.6 The order of laying which maintains an open face should be used.

11.7 After final compaction the surface course will conform to the surface tolerance levels.

NG12 Cutting and Trimming

12.1 Cut units should only be incorporated at the perimeter of the pavement, at intermediate restraints and around obstacles.

12.2 Sizes smaller than one quarter of the original plan size should be avoided.

12.3 Flags may be cut using a block splitter or bench mounted water-cooled power saw. Chamfers can be produced using the bench saw.

12.4 Flags should be trimmed to fit after laying full paving flags.

NG13 Compaction

13.1 Compaction should not occur within 1m of any laying face.

13.2 No areas should be left uncompacted at the completion of a day's work.

13.3 Prior to compaction all debris must be removed from the surface.

13.4 Use a vibrating plate compactor to bed the flags into the laying course, making two or three passes when laying flexibly.

13.5 Use a pavior's maul to bed the flags into the laying course when laying on a cement mortar.

NG14 General

14.1 Where flags are laid abutting drainage channels or fittings, the surface of the flags shall be between 3mm and 6mm above the channel or fitting.

14.2 Where flags are laid abutting gullies, the surface of the flags shall be between 3mm and 6mm above the gully grating and frame.

14.3 For flags laid flexibly, the surface course should be inspected soon after completion and at regular intervals thereafter, brushing in additional sand where necessary.