CARES Technical Approval Report TA2-5001

Assessment of the Kwikastrip Product and the Quality System for Production

KWIKASTRIP®

CARES TECHNICAL APPROVAL

UKAS PRODUCT CERTIFICATION 5001

Product

Kwikastrip® Reinforcement Continuity System

Produced and supplied by:

Halfen Ltd
Humphrys Road
Woodside Estate
Dunstable
LU5 4TP

1 Product Summary

Kwikastrip is a reinforcement product designed to maintain continuity across construction joints in concrete structures in a time saving and cost effective manner.

Kwikastrip consists of selected reinforcement, pre-bent and housed in a purpose-designed carrier casing manufactured from indented galvanised steel.

On site, the entire unit is fixed to the shutter and cast into the front face of the wall. After the formwork is struck, the carrier case lid is removed to reveal the connection legs (or starter bars) lying inside the casing. These legs are bent out by the contractor, ready for lapping the main reinforcement of the consequent pour.

The casing remains embedded in the wall, providing a rebate and key for the subsequent pour of the adjoining member and eliminates the need for traditional preparation such as scabbling at the joint.

1.1 Scope of Application

This approval covers use of the Kwikastrip reinforcement continuity system in a horizontal orientation in reinforced concrete structures designed in accordance with BS8110: Part 1, which are subject to static loading in non-cryogenic environments.

1.2 Design considerations

In the UK, the use of Kwikastrip product types and construction jointing methods, which require the site bending of in-situ reinforcement, is a matter for the engineer's approval. The most fundamental considerations are the rebending of high yield reinforcement (which is a prerequisite of the Kwikastrip reinforcement continuity system), end anchorages and the bearing stress at bends:

BS8110 Paragraph 7.2 states *"It is permissible to bend grade 250 reinforcement projecting from concrete provided that care is taken to ensure that the radius of bend is not less than that specified in BS8666. Grade 500 bars should not be bent, rebent or straightened without the engineer's approval."*

BS8110 clause 3.12.8.22 states *"End anchorages in the form of hooks and bends should only be used to meet specific design requirements and should conform to BS8666."*

BS8110 clause 3.12.8.24 states that *"In no case should this be less than twice the radius of the test bend guaranteed by the manufacturer of the bar, nor less than the radius required to ensure that the bearing stress at the midpoint of the curve does not exceed the values given in 3.12.8.25."*

Whilst end anchorages and bearing stresses are a matter of design, rebending of reinforcement is a matter of product suitability and workmanship. This technical approval demonstrates that the performance of construction joints is not adversely affected by use of the Kwikastrip reinforcement continuity system.

1.3 Conclusion

It is the opinion of UK CARES that the Kwikastrip reinforcement continuity system is satisfactory for use within the stated limits of this technical approval when used in accordance with the manufacturer's instructions and the requirements of this certificate.

B. Bowsher
Executive Director

Issue 3 (September 2008)

2 Technical Specification

Kwikastrip consists of reinforcement, pre-bent and housed in a purpose-designed carrier casing. The Kwikastrip assembly is fabricated off-site in a CARES quality assured environment.

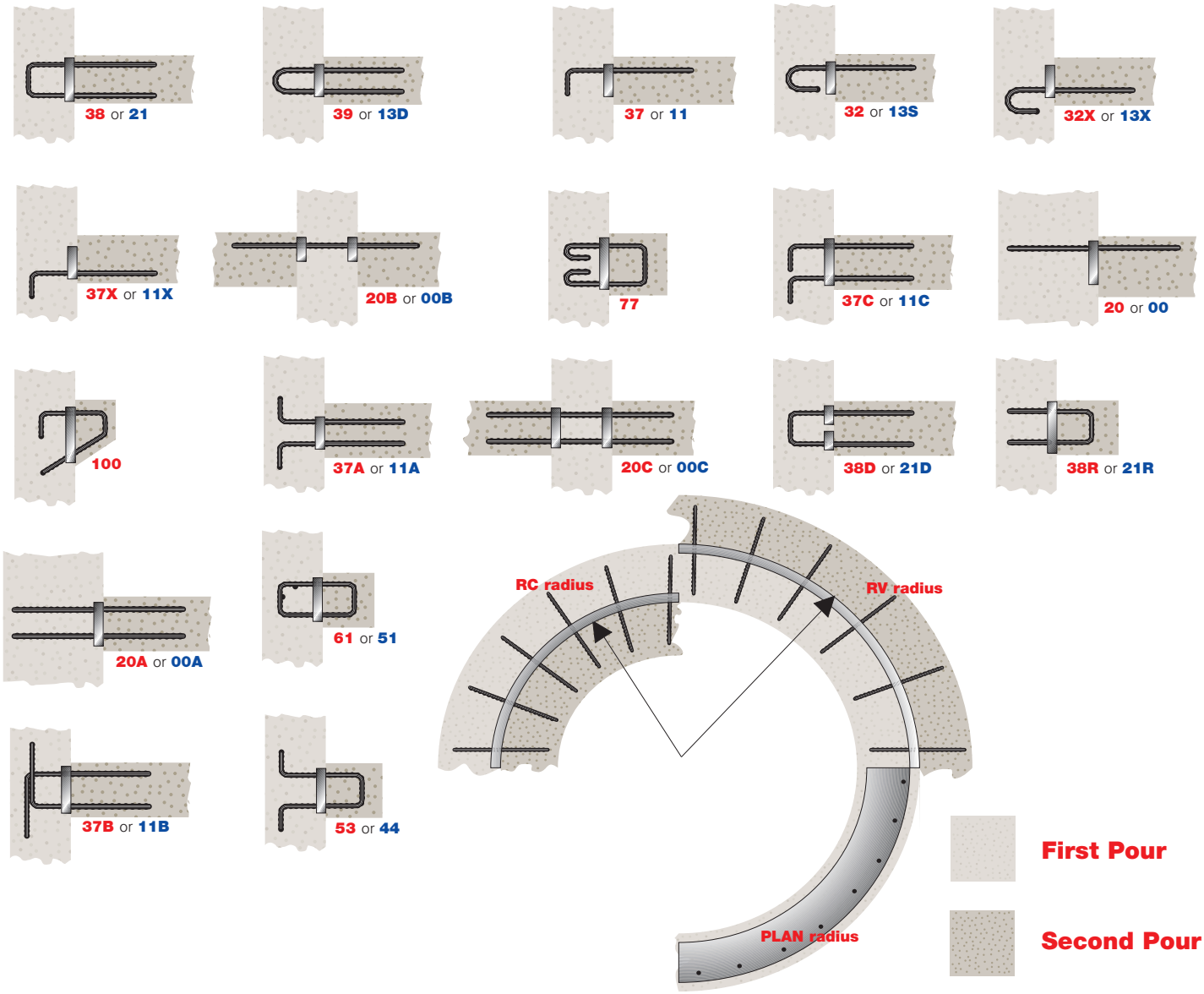
The carrier casing is prefabricated from galvanised steel sheet, indented to improve bond and key with the concrete.

The type of reinforcement selected by Halfen is produced by either the quenched and self-tempered process route (QST) or the 'stretch' process route, which provides a suitable degree of ductility, ensuring that it complies with the tensile requirements of BS4449, Grade B500B and B500C reinforcement after prefabrication and rebending on site. The material is CARES approved, ensuring consistent compliance with the product standard. Material processing is CARES approved to ensure full traceability from steel mill to construction site. Kwikastrip is available in bar sizes from B10 to B16. Bending is generally to BS8666:2005, except for the bends to be rebent on site, which are formed using a minimum former diameter of 6.0d.

Kwikastrip is available in a wide range of customer specified shape options (see below) – any of which is almost infinitely variable in any dimension. Kwikastrip can also be supplied radiused in the planes illustrated (see below).

The manufacturer's sales literature offers scheduling advice for the engineer and contractor.

Shape options



3 Product Performance and Product Characteristics

3.1 Reinforcement Tensile Properties

Mechanical tests on the reinforcement showed that the material, after bending and straightening, complied with the tensile requirements of BS4449 Grade B500B and B500C, exhibiting values for Total Elongation at Maximum Load (Agt) of greater than 5%.

3.2 Strength of Joints

Structural tests showed that the flexural strength and shear strength of construction joints formed with the Kwikastrip reinforcement continuity system are no less than those of equivalent traditionally formed construction joints.

3.3 Serviceability Limit States

3.3.1 Deflection

The deflection of elements is not a function of this product insofar as joints formed using Kwikastrip were able to ensure full structural continuity during testing and did not exhibit any significant additional rotation relative to the joint.

3.3.2 Cracking

In the tests conducted, the widths of flexural cracks in the joint regions at reinforcement stresses of 300 N/mm^2 were approximately 0.4mm, which compare to 0.3mm according to calculations by BS8110 Part 2. There is, however, nothing to indicate that the extra crack width was associated with the continuity system and crack widths in joints are, in general, likely to exceed values assessed by codes that use methods based on conditions in regions of constant bending moment, e.g. corners at slab/wall interface.

3.3.3 Calculation of Crack Widths

Crack widths at joints are not generally assessed in BS8110 designs but where a calculation is required, the following equation can be used:

$$w = \frac{\sigma_s^{\,2} \phi_s}{4 E_s \tau}$$

Where
- σ is the steel stress in the crack,
- ϕ_s is the bar diameter,
- τ is the average bond stress,
- w is the crack width at the level of the centre of the steel,
- E_s is the elastic modulus of the steel.

4 Installation

The Kwikastrip unit is either nailed (through casing) to the shutter face, or the projecting anchorage reinforcement is securely wired back to the main reinforcement cage and the shutter offered up to it. The Kwikastrip unit is therefore sandwiched in position between the shutter and main reinforcement cage. The concrete is then poured and the entire unit is cast into the face of the concrete element/wall (see figure 1).

Stripping the shutter reveals the lid on the wall face. The lid is removed to reveal the connection legs (see figure 2), which should be bent out using the available straightening tool (see figure 3). Anchorage is achieved via the reinforcement delivered projecting out of the casing. Lap is achieved via the bent-out connection legs, which are spliced to the main reinforcement of the subsequent concrete pour (see figure 4).

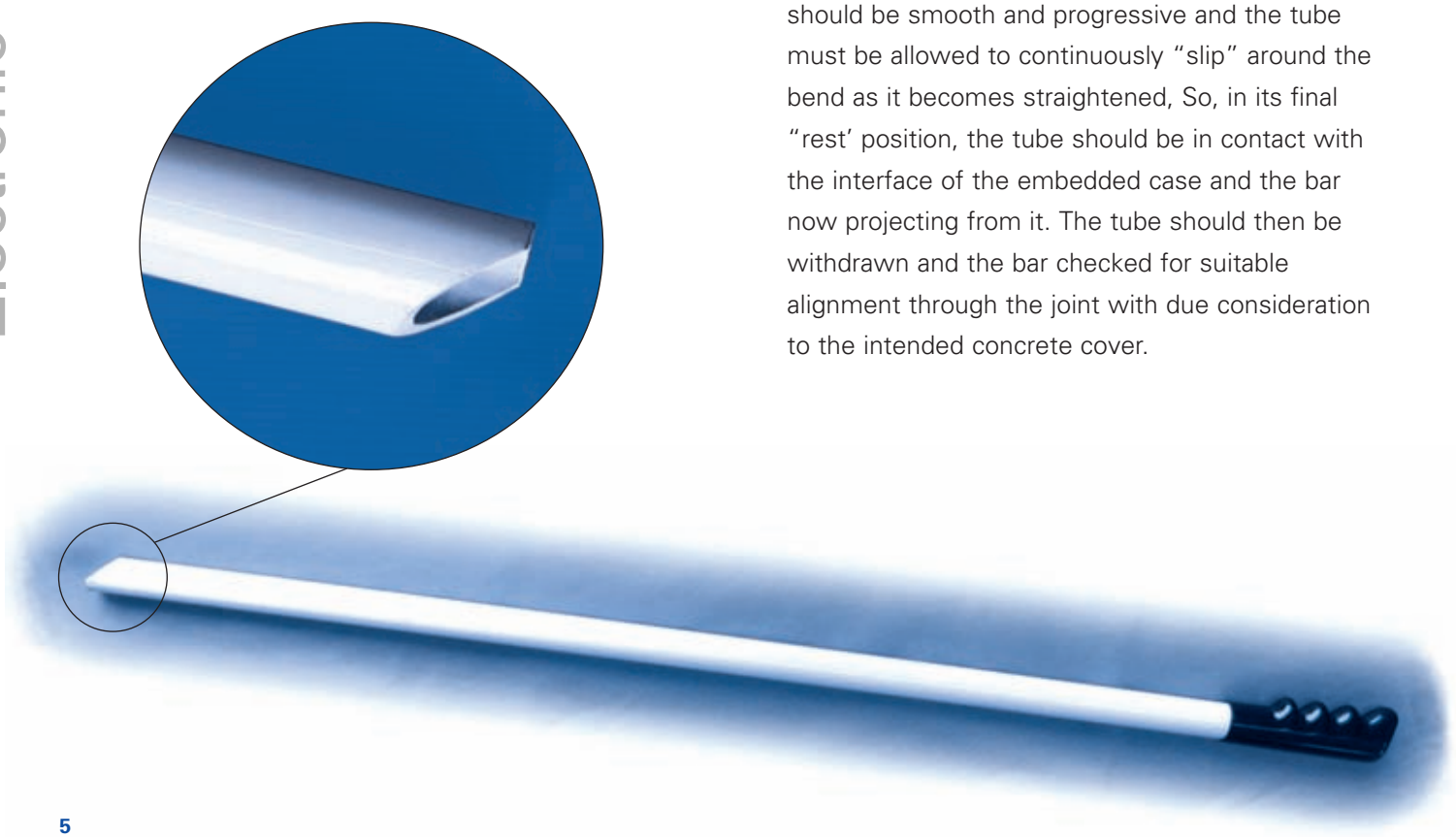
4.1 Straightening of Bars

Reinforcement shall only be straightened when the temperature of the steel is 5°C or above. Where the temperature of the reinforcement is below 5°C, reinforcement may be indirectly warmed to a temperature not exceeding 100°C but no form of direct heat treatment shall be applied to the reinforcement element.

The available straightening tool (see below) enables the connection leg to be straightened correctly and efficiently. The use of other implements (e.g. hammers, scaffold tubes) will result in adversely kinked starter bars and unacceptable work hardening of the reinforcement that may adversely affect the performance of the system.

The straightening tool is a steel tube with a specially shaped end and an internal diameter only slightly greater than the diameter of the bar to be straightened. The tube wall thickness adequately ensures that the tube will not flex under load. The length of the tube provides the necessary leverage to eliminate undesirable "jerky" movements, otherwise caused as a result of too great a physical effort required by the operative.

The tube should be placed over the bar and located at the start of the bend. The end of the tube is specially shaped (see inset photo) in order to minimise undesirable point contact of the tube on the bar and, more importantly, to provide continuous support to the outside of the bend during straightening. The straightening operation should be smooth and progressive and the tube must be allowed to continuously "slip" around the bend as it becomes straightened, So, in its final "rest' position, the tube should be in contact with the interface of the embedded case and the bar now projecting from it. The tube should then be withdrawn and the bar checked for suitable alignment through the joint with due consideration to the intended concrete cover.



For aesthetic and practical benefit the Kwikastrip straightening tool is powder coated with a white finish and has a rubber handle grip, which make it both comfortable to use and clearly distinguishes it from any other tube oddments potentially lying around the site.

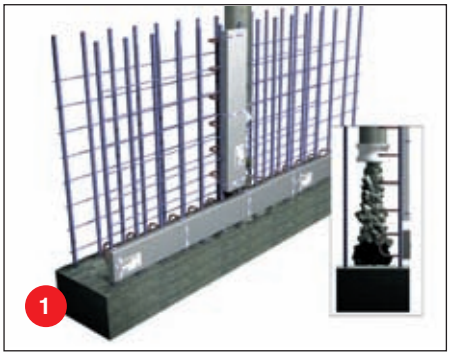
4.2 Storage

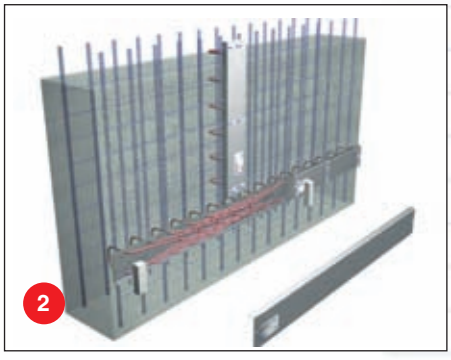
Kwikastrip should be stored in a manner that prevents mechanical damage and corrosion.

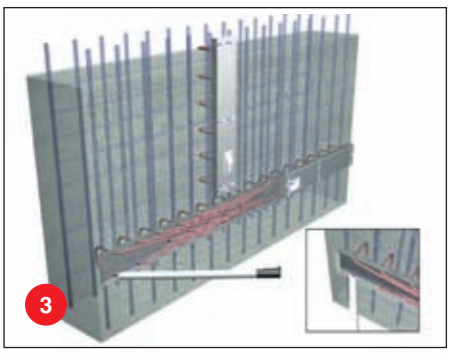
5 Safety Considerations

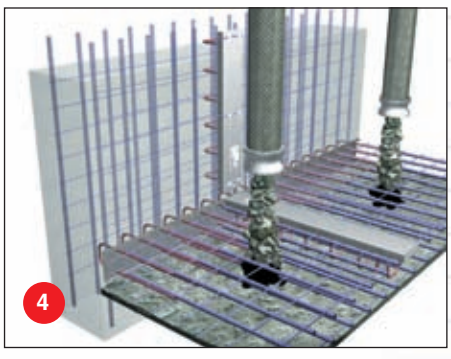
Wherever possible, Kwikastrip is palletised for mechanical handling. Individual Kwikastrip casing weights up to 25kg may be handled manually with care. Heavier cases (up to 100kg) require mechanical handling equipment. Protective gloves should be worn when removing the casing lids and straightening the bars.

Heat should not be applied to the Kwikastrip casing as it is galvanised and may produce dangerous fumes.









6 Product Testing

6.1 General

The Kwikastrip reinforcement continuity system was evaluated in two stages:

6.1.1 The reinforcement was subject to independent mechanical testing to establish its suitability for bending during the prefabrication process and rebending through 90 degrees during the straightening process on site and subsequent compliance with the tensile requirements of BS4449.

6.1.2 Kwikastrip reinforcement continuity system samples were subject to a programme of full-scale structural testing in concrete to evaluate the performance of construction joints under combinations of high shear and high flexural loading.

6.2 Mechanical Testing

Reinforcement was subject to a bendability test devised by CARES, which consisted of bending the reinforcement through 90 degrees over a steel former, straightening and examination of the inside of the bend for signs of fracture. The test was conducted twice on each sample.

Reinforcement was also subject to a tensile test regime devised by CARES, which consisted of bending the reinforcement through 90 degrees over a steel former and straightening with the Kwikastrip tool prior to tensile testing to measure Ultimate Tensile Strength, Yield Strength and Elongation at Maximum Load (Agt). The particular QST and 'stretch' material selected was found to comply with the tensile requirements of BS4449 Grade B500B and B500C (Clause 11.1, Table 7).

6.3 Full Scale Structural Testing

Kwikastrip reinforcement continuity system samples were subject to a programme of structural testing at Imperial College (Load Testing of Kwikastrip Wall/Slab Joint Specimens. Department of Civil Engineering, Imperial College of Science, Technology and Medicine, by A. D. Pullen).

Several wall/slab joints and column/nib constructions were formed in reinforced concrete, including construction joints formed using the Kwikastrip reinforcement continuity system. These tests were full-scale in terms of bar sizes and member depths. In all wall/slab specimens the continuity reinforcement was 16mm diameter deformed bar, chosen as being the largest bar size normally used in the Kwikastrip reinforcement continuity system and which imposes the greatest stresses on the surrounding concrete and the most severe demands on the reinforcement in relation to bending and straightening.

The series of reinforced concrete samples, some of which were cast in a manner to simulate poor concrete compaction, were subject to various loading conditions representing high shear or high bending moment loading. The displacements and crack widths were measured in relation to applied load. The ultimate loads were measured.

In all cases the samples exceeded the ultimate loads calculated from BS8110. The maximum crack width at the joint was 0.4mm. Although BS8110 does not cover cracking at joints, this exceeded the code requirement of 0.3mm for areas of constant bending. There is no reason to suspect that this was any worse than that experienced in traditional construction joints.

The structural tests were evaluated by Professor P. E. Regan (Evaluation of the Kwikastrip Continuity System from tests of Reinforced Concrete Specimens, by Professor P.E. Regan).

NOTE: *The following photographs indicate the type of structural tests conducted and the typical mode of failure, and are included for general information only.*

Post-test cracking after loading slab 300mm from wall/slab junction. Kwikastrip continuity reinforcement was incorporated in top of slab only.

Test configuration as (6) above, except continuous polystyrene section cast into joint soffit/interface to simulate poor compaction of concrete in wall.

Post-test cracking after loading slab 800mm from wall/slab junction. Kwikastrip continuity reinforcement was incorporated top and bottom of slab.

7 Quality Assurance

The Kwikastrip reinforcement continuity system is produced by Halfen under an ISO 9001 quality system that is certified by CARES: Certificate number 1053.

The quality system monitors the production of the Kwikastrip reinforcement continuity system and ensures that materials and product remain within the limits of this technical approval.

8 The Building Regulations

8.1 The Building Regulations (England and Wales)

Structure, Approved Document A

The Kwikastrip reinforcement continuity system, when used in BS8110 based designs using the data contained within this technical approval, satisfies the requirements of *The Building Regulations (England and Wales), Approved Document A.*

Materials and Workmanship, Approved Document, to support regulation 7

This technical approval gives assurance that the Kwikastrip reinforcement continuity system complies with the material requirements of BS8110 by virtue of *Clauses c.ii, d and e* of the approved document.

8.2 The Building Regulations (Northern Ireland)

Part B, Materials and Workmanship

This technical approval gives assurance that the Kwikastrip reinforcement continuity system complies with the material requirements of BS8110 by virtue of regulation *B3, Deemed to satisfy provisions regarding the fitness of materials and workmanship.*

8.3 The Building Standards (Scotland) Regulations

Part B, Fitness of Materials

This technical approval gives assurance that the Kwikastrip reinforcement continuity system complies with the material requirements of BS8110 by virtue of *Clause B2.1.*

Part C, Structure

The Kwikastrip reinforcement continuity system, when used in BS8110 based designs using the data contained within this technical approval, satisfies the requirements of *The Building Standards (Scotland) Regulations, Part C, C2.1, clause b. construction, ii.*

9 References

- BS 4449:2005 Steel for the reinforcement of concrete. Weldable reinforcing steel. Bar, coil and decoiled product. Specification.
- BS 8666:2005 Scheduling, dimensioning, bending and cutting of steel reinforcement for concrete. Specification.
- BS 8110-1:1997 Structural use of concrete. Code of practice for design and construction.
- BS 8110-2:1985 Structural use of concrete. Code of practice for special circumstances.
- BS EN ISO 9001:2000 Quality management systems. Requirements.
- Evaluation of the Kwikastrip Continuity System from tests of Reinforced Concrete Specimens, by Professor P.E. Regan.
- Load Testing of Kwikastrip Wall/Slab Joint Specimens. Department of Civil Engineering, Imperial College of Science, Technology and Medicine, by A. D. Pullen.
- The Building Regulations (England and Wales).

- The Building Regulations (England and Wales), Materials and Workmanship Approved Document to support regulation 7.
- The Building Regulations (England and Wales), Structure, Approved Document A.
- The Building Regulations (Northern Ireland).
- The Building Regulations (Northern Ireland), Part B, Materials and Workmanship.
- The Building Standards (Scotland) Regulations.
- The Building Standards (Scotland) Regulations, Part B Fitness of Materials.
- The Building Standards (Scotland) Regulations, Part C Structure.

10 Conditions

1. The quality of the materials and method of manufacture have been examined by CARES and found to be satisfactory. This technical approval will remain valid provided that:

   a The product design and specification is unchanged.
   b The materials and method of manufacture are unchanged.
   c The manufacturer complies with CARES regulations for technical approvals.
   d The manufacturer holds a valid CARES Certificate of Product Assessment.
   e The product is installed and used as described in this report.

2 Kwikastrip® is a registered trademark of Halfen Ltd

3 CARES make no representation as to the presence or absence of patent rights subsisting in the product and/or the legal right of Halfen to market the product.

4 Any references to Standards, Codes or legislation are those which are in force at the date of this report.

5 Any recommendations relating to the safe use of this product are the minimum standards required when the product is used. These requirements do not purport to satisfy the requirements of the Health and Safety at Work act or any other relevant safety legislation.

6 CARES does not accept any responsibility for any loss or injury arising as a direct or indirect result of the use of this product.

7 This Technical Approval Report should be read in conjunction with CARES Certificate of Product Assessment No.5001. Confirmation that this technical approval is current can be obtained from CARES.

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