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To investigate the fundamental causes of utility air voids content failures in asphalt layers to achieve Specification for the Reinstatement of Openings in Highways (SROH) compliant performance

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HIGHLIGHTS

- The link between SROH air void (AV) limits and performance of footways is non-proven.
- Footways reinstatement assessment in SROH is not in accordance with British Standard.
- There is evidence of well performing reinstatements despite noncompliant air void.
- Errors and variability in density measurement generate biased air void results.
- Agreed performance guarantee by the undertaker would be a more reliable measure.

GRAPHICAL ABSTRACT

Satisfactory performance of reinstatements works even comprising SROH non-compliant air voids contents. Photograph taken; (a) after 27 months of installation, (b) after 12 years of installation (Stopps, 2014).

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ABSTRACT

The linkage between air voids content and durability in footways reinstatements with the limits currently in SROH is non-proven and unsupported by evidential research or trial data. Compounding of errors, particularly in density measurement of core samples and subsequent variability, generate biased air void content results that make the compliance largely a matter of chance. This led to a very wide range of predicted outcomes, putting both the contractor and the client at unacceptable risk. The use of a measured in situ air voids content criteria in a specification for footway reinstatements, where the entire operation is in restricted areas with hand laying process using recipe mixed materials, cannot be sustained on technical grounds with respect to relevant British Standard and Transport Research Laboratory (TRL) guide. Taking account of the service loads, nature and scale of works in footways, an in-service guarantee by the undertaker for an agreed extended period, linked to an allowable intervention level, could be a simple, realistic and acceptable solution, ensuring a durable reinstatement that removes the financial risk of failure from the highway authority.

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1. Introduction

Coring (the taking of samples of asphalt materials) programmes of utility reinstatements initiated by the UK Local Authorities have been identifying consistent failure in respect of air voids contents in surface course material of footways when assessed against the requirement of the Specification for the Reinstatement of Openings in Highways (SROH) [1] for air voids content compliance. This is an issue which currently affects all National Joint Utility Group (NJUG) members of the UK, presenting a significant and growing challenge as more Local Authorities in the UK apply the SROH air voids content standard to utility reinstatements. This study is intended as an introduction and overview investigating some possible causes for noncompliance with the SROH by the undertakers, in terms of the air voids content in asphalt materials.

The Public Utilities Street Works Act 1950 [2] was replaced by the Public Utilities Act 1991 by implementing some of the recommendations of the 1985 Horne Report [4] on roads and the public utilities. As per article 70 and 71 of New Roads and Street Works Act 1991 [3], it is the responsibility of the Undertaker by whom street works are executed to reinstate the road/footway surfaces complying the requirements prescribed in specification, whereas, responsibility for inspecting the quality of reinstatements lies with the UK Local Authorities.

For reviewing the existing Public Utilities Street Works Act 1950 (PUSWA), the UK Government set up a committee chaired by Professor Horne in 1984. PUSWA was replaced by the 1st edition of SROH in 1992 by implementing some of the recommendations from Horne Report [4], and, the second edition of SROH [5] was released in 2002 introducing a number of changes including end result specification, a new road category, alternative specification for materials, layer thickness, compaction methods and/or new compaction equipment. Currently the reinstatement of utility works is covered by the 3rd edition of SROH [1] which was enforceable from October 2010 in England.

The third edition of SROH contains three sections, namely Specification, Appendix and Notes for Guidance (NG). It defines Specifications and Appendices as integral part of the code of practice and hence enforceable under law, whereas, the NG are complementary to support the practitioners. The specification for compaction control in the first edition of the SROH was in terms of the method to be applied (hereinafter referred to as 'method specification'), whereas in the second and third edition, end-product specification (hereinafter referred to as 'end result specification') through complying with an in situ air voids content requirement (Table S10.1 in SROH) of all asphalt materials was introduced. The guidance for achieving the specified air void content of asphalt mixtures using the specified materials and compaction plants has been provided as NGA in the current edition of SROH (Table NGA8.3 in SROH).

The genesis of the move toward Quality Assurance (QA) began in 1956 with the American Association of State Highway Officials (AASHO) Road Test (1956–1958), and the analyses that emanated from that historic study. The unsuspected discovery of the large magnitude of the variability in materials and construction was found in this road test and led to the conclusion that specifications must be improved [6,7]. Highway engineers realised that these variabilities were not being handled properly in specifications [8]. To establish realistic specification limits, several state Departments of Transportation (DoT) started to measure the variability of asphalt volumetric properties, air voids content, binder content and grading in the 1960s [9–11]. After the AASHO Road Test, a sufficient number of unbiased test results of construction materials and techniques also became available to expose the true variability of these results and their relationship to specifications [12].

Coring programmes of utility reinstatements initiated by local authorities consistently show significant failure rates in respect of air voids contents in surface course material when assessed against the SROH. Utility undertakers are experiencing difficulties in complying with the SROH air voids content requirement while using the specified materials and construction method and also following the guidance on compaction plants (NGA 8.3) quoted in SROH [13].

This research has been initiated to examine the achievability of the SROH specified air voids content limits using currently recommended materials and operating methods stipulated in the SROH. This study was also intended as an introduction and overview investigating possible causes for noncompliance with the Specification for the Reinstatement of Openings in Highways (SROH) by the undertakers, in terms of the air voids content in asphalt materials. The observations and conclusions of this study are primarily based on the review of the published literature, related standards and three completed trial studies conducted on compaction methods and equipment for reinstatement by Affinity Water – London Borough of Enfield [14], Transport Research Laboratory [15] and Balfour Beatty – Pavement Testing Services (PTS) Ltd [16].

2. Method of research

This research highlights the process and factors to be considered for establishing specifications and associated limiting values and the performance of street reinstatements compared with those embedded within SROH by:

- Reviewing the results and associated variability obtained from the available related trial studies concerning the performance of SROH,
- Reviewing the published documents regarding the measures for establishing a realistic specification and
- Reviewing the related Standards regarding the use of a measured in situ air voids content criteria in a Specification for footway reinstatements, where the entire operation is in restricted areas with hand laying process using recipe mixed materials.

3. Review of results from published reinstatement trials

So far, a comprehensive review has not been conducted on the performance of the utility reinstatement with respect to current edition of the SROH. However, the London Borough of Enfield in partnership with Corehard Laboratory Ltd, Affinity Water and SQS Ltd conducted a trial in 2012 [14] and Balfour Beatty – Pavement Testing Services (PTS) Ltd in 2011 [16] for determining the suitability of the compaction devices stipulated in the code of practice. Transport Research Laboratory (TRL) conducted a study in 2003 [15] for validating the performance of 600–1000 kg/m single drum roller in relation to the compaction of the asphalt materials for inclusion in SROH. These trials were not truly conducted for assessing the achievability of the SROH covering all possible scenarios that could be encountered while executing the reinstatement works in real life:, however, the trend of performance of the compaction plants used, as well as the achievability of the SROH air voids content requirement can be obtained by reviewing the results from these trials.

The methods used within these three trials allowed for full and controlled scrutiny of material selection, equipment selection, and methods applied or required when compacting both unbound and asphalt materials. Continuous monitoring of the methodology prescribed, temperature of material, and digital imaging utilised to ensure no deviation from the requirements. All testing was carried out under controlled and accredited by laboratory conditions. This