



Introduction

There is increasing pressure on the construction industry to use recycled and alternative materials in place of new aggregate. An abundant alternative is recycled concrete aggregate (RCA) from crushed construction or demolition debris. Where a suitable source is available, such as at reconstruction works or brownfield sites, considerable cost savings can result.

RCA has been widely used in cement-bound material (CBM) for base layers in roads and airfield pavements for some years. It has also been used in pavement quality concrete (PQ) in some countries and the Specification for Highway Works has recently been updated to allow the use of RCA in PQ for trunk roads in England.

Background

RCA produced from demolition debris often contains brick and other foreign materials and these can limit its use. However, cleaner sources exist which have wider applications, for instance from recycling centres and crushed concrete slabs in roads and airfields. BRE Digest 433 describes three classes of RCA and their suitability for various civil engineering applications.

Crushed RCA is classified into coarse and fine (<5mm) fractions. Course RCA from clean sources usually provides strength in excess of 100kN (10% fines value test, BS812) and satisfies the quality and grading requirement of BS882 and therefore has the potential to provide 100% of the coarse aggregate in concrete.

However, at high levels there may be changes in properties, such as a reduction in compressive strength and an increase in required water content, compared to using new aggregate.

Fine RCA is generally used at lower levels in concrete and needs a higher level of quality control to provide low contaminant levels.

BS882 is limited to aggregates from natural sources, however, other relevant standards include BS6543, which provides guidance on the use of waste and recycled aggregates in civil engineering and building and BS8500, which specifies detailed requirements for RCA in terms of composition and impurities for wider construction uses. RILEM Report 22 provides a state-of-the-art review of demolition, re-use of demolition arisings and national production and utilisation figures for some countries.

Most significantly for road building, Highways Agency has recently updated the Specification for Highway Works (SHW) and the Design Manual for Roads and Bridges to permit the use of crushed concrete. The full range of application now includes PQ concrete, CBM base course and sub-base, unbound sub-base, capping, embankment and fill.

Overcoming the Barriers

Despite the pressure, particularly from Government clients, to increase the levels of recycling in construction, the uptake is generally slow. A recent review of recycling in transport infrastructure (Reid and Chandler (2001)) itemised the barriers to wider use of recycled materials and recommends actions to overcome them.

While the specifications to use RCA in pavement construction now exist, they may not have become widely known and there may be reluctance to use them for the first time. This Technical Guidance Sheet aims to help overcome these barriers. Some examples of the successful use of RCA in paving are given in the next section.

Case Studies

Scottish and Newcastle Breweries, Regional Distribution Centre, Thatcham. Fitzpatrick Ltd.

This site, being developed by Gazeley Properties, was formerly a paper mill. Demolition works had left a huge stockpile of 45,000m³ of loose, crushed material.



The development footprint covered over 70,000m² and suffered from a high water table, which made many areas of the site un-usable after heavy rain. The new building covers approximately half of this area and the rest is predominantly concrete hardstanding.

The design and build specification called for 225mm of C40 concrete over 150mm CBM3 for the building footprint, while the hardstanding required 175mm of air entrained PQ concrete over 200mm of CBM3. The CBM3 material was required to comply with SHW Series 1000 and to be made with crushed concrete aggregate.

The 26,000 tonnes of crushed concrete required were reprocessed through a crusher and screen, then mixed on site using an Elba 60 batching plant and laid with an ABG Titan paver. No additional aggregate was required for the ordinary Portland cement mix. Typical seven-day strengths of 12N/mm² were achieved and in-situ densities met the specification.

By reusing the crushed concrete, nearly 2,500 truck movements were saved. The general reaction of client, end-user and contractors was that the CBM3 base provided the ideal working platform for the whole construction process, despite the difficult conditions.

British Airport Authority, Pavement Team

The Pavement Team works as a partnership between BAA and its contractors and suppliers on the construction and maintenance of airfields including Heathrow, Gatwick and Stansted. AMEC is the partnership paving contractor.

From 1995, all 'waste' and broken out concrete has been crushed and stockpiled in managed areas for subsequent re-use. Since then, about 210,000 tonnes of concrete has been recycled with an estimated cost saving of £1.8 million. This has resulted in a reduction of 42,000 truck movements amounting to 1.85 million road miles.

Concrete Pavement Recycling: The Austrian Way

By the early 1990s, parts of the Vienna – Salzburg motorway had seen nearly 50 years of service. Between 1991 and 1993, 30km were reconstructed with the intention of fully recycling the old PQ concrete into a new PQ layer. Figure 1 shows, schematically, how the system worked.

The original PQ concrete was shattered and then crushed and screened and 70% was reused as aggregate in the new PQ concrete layer. Particles ranging in size from 32mm to 4mm were used in this layer. The remaining 30% below this size, was blended with some of the original granular sub-base and Portland cement to form the new cement bound sub-base.

The old PQ concrete contained some asphalt material from a support layer or laid during maintenance. It was determined from laboratory tests that, provided the bituminous content of the aggregate was less than 20%, then the flexural strength of the new PQ concrete would still be better than that made with virgin quartzite gravel. A virgin sand was required for the new PQ concrete mix.

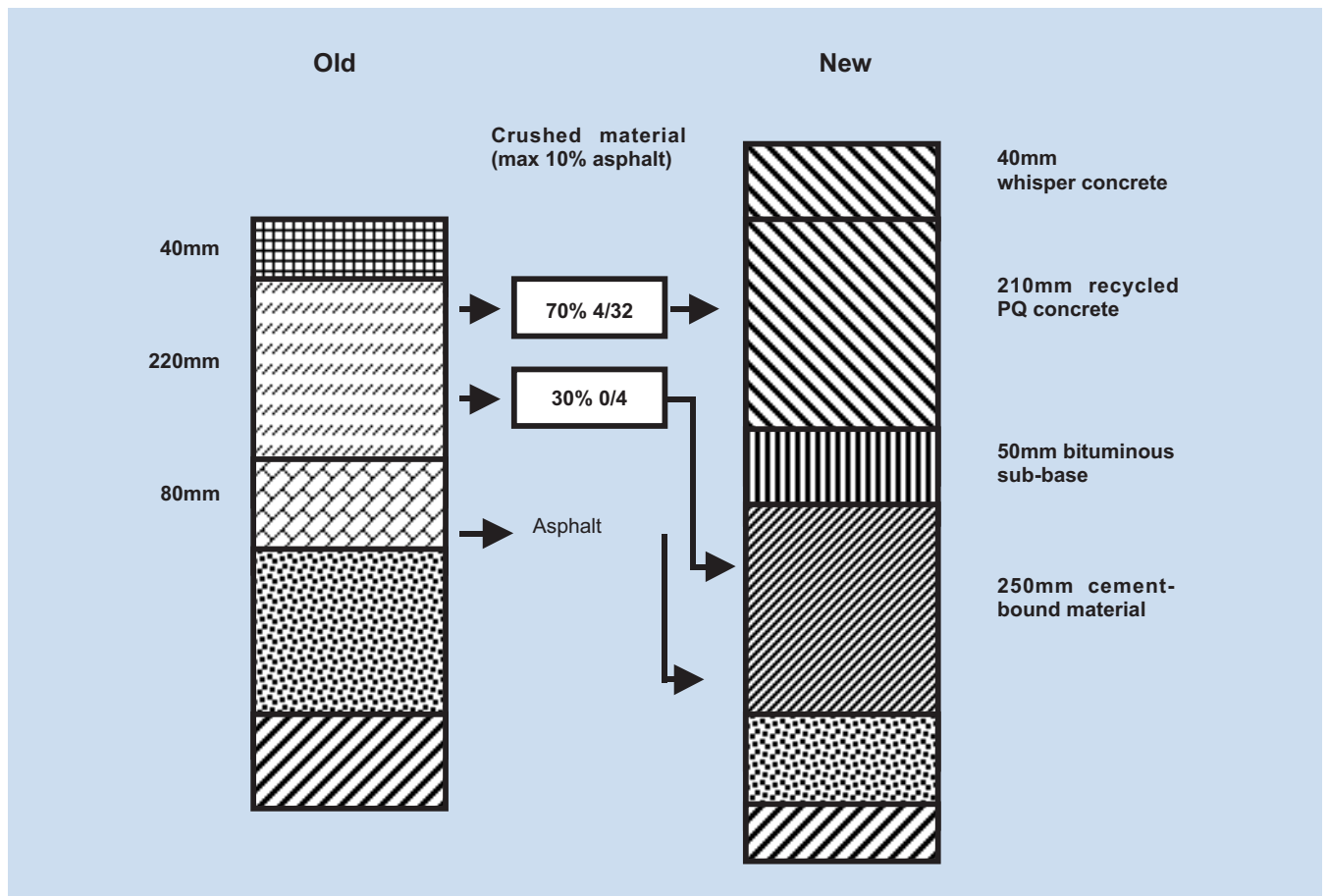


Figure 1. Schematic of the Austrian recycled PQ concrete pavement

By using this mix of 70% old PQ concrete coarse aggregates and 30% new sand, the resulting concrete with 365kg/m^3 of Portland cement plus air entraining agent and plasticiser, performed as well as concrete made with totally new aggregates. In fact, the RCA mix had better flexural strength because of the better bond to the crushed concrete surface. The PQ concrete layer was then surfaced with 40mm of 'whisper concrete'.

Summary

The pressures for increased recycling are growing. Recycled concrete aggregate offers the concrete paving industry a significant chance to increase the rate of recycling and the specifications to do so are now in place. The use of recycled concrete aggregate in cement-bound bases is increasing in the UK and cost and environmental benefits have been recognised. But the next challenge is to use recycled concrete in pavement quality pavement layers. This has already been achieved successfully overseas.

References

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Acknowledgments

Guidance Sheet E1 is one of a series of guidance notes prepared for use by Britpave members.

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