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ASSOCIATION connections

AUSTRALASIAN (IRON & STEEL) SLAG ASSOCIATION

www.asa-inc.org.au

Editorial

Iron and steel slags have historically been considered industrial wastes, residues, by-products, recycled products and similar names around the world. This thinking can limit possibilities about their use. Viewing them as the 'left over' part of a primary process attaches some stigma to finding end uses and possible environmental risks. As co-products (industrial process where a substance must also be formed along with the substance being manufactured) iron and steel slags are not wastes.

Soaking sample for saturated undrained RLT test.

Over the last 20 years iron and steel slags produced throughout Australasia have been thoroughly analysed, classified and monitored with regular reports published each year (available @ www.asa-inc.org.au). As co-products of the quality controlled iron and steel manufacturing process, the basic composition and properties of the slag products are highly consistent, as confirmed by ongoing monitoring and quality assurance practices.

The Global Slag Conference held in November provided up to date research on applications which show new or improved use for a range of applications using the unique characteristics of the slag product rather than simply substituting for some 'natural' material. In this issue the papers 'Regenerative Frictional Properties of slag Aggregates', 'The Rut Resistant Performance of Slag Aggregates' and 'Slag Roadbase Case Studies' each demonstrate specific characteristics of slag products that set them apart.

Elsewhere in this issue are stories on the joint Standards project to reactivate the BD 031 Standard, the successful conclusion to the Sustainability Victoria project, Preparation of a new slag product data sheet and the launch of the Associations redesigned website.

David E Jones

Association Website Undergoes Major Revamp

In 1998 when the Australasian (iron and steel) Slag Association (ASA) decided to go 'online' with its message about iron and steel slags, this decision could have been viewed as a 'me too' popularist one. The stated objective for the website was to provide an efficient method to get the mass of technical papers out of storage and make them available to the public, in particular engineers and key influencers. This 'open source ' approach to access of information not only pleased members but also gave the organisation an increased recognition and presence within the World Wide Web [www]. Today, that 'me too' decision way back in 1998 has been vindicated as a prudent one with more than 1.9 million hits, 359,950 unique visitors, and 308,777 downloads of electronic material (technical publications). The library continues to be a significant resource, with new material being added over time.

Our 3rd generation website's revamp was deemed necessary in bringing the existing database up to modern standards to cater for both the growing demand for its content and the need to remain compatible with modern search trends and tools. The website redesign architecture is more intuitive and simpler to navigate. So much has changed in the online world since 1998, the current changes are aimed at bringing both freshness and new functionality. As part of the online presence of the ASA, the *Connections* newsletter has moved to an e-publication, potentially increasing its reach and accessibility. Regular subscribers receive a reminder about each new publication and visitors to the website can view the current and past issues.

The ASA welcomes this fresh new approach to its online administration and looks forward to continuing to move forward with this technology in the coming years. The association is also very eager to receive feedback on the changes.

Alison Fitzgerald

THIS ISSUE

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CONNECTIONS EDITORIAL TEAM

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Connections is a quarterly publication with an online circulation of 1,500 copies

Association joins in joint project to update Standard BD031 – Fly ash, Slag and Amorphous Silica

Standards Australia (SA) in late October 2010 accepted in principle a draft 'Project Application' for the reactivation of BD031 (Supplementary Cementitious Materials For Use With Portland Cement) committee responsible for AS3582 parts 1, 2 & 3. Our proposed 'open and transparent' methodology for conducting the stakeholder consultation has been roundly supported by the associations membership.

Stages 1 - 4 are now complete.

1. Consultation (Association/s)
2. Proposal (Standards)
3. Constitution of Committee (Standards Australia to seek nominations to fill vacancies)
4. Technical Committee Review (Association/s)

Stage 5 - Commenced in January 2011. 'Review of code'. An independent chair for the committee work during 2011 has been appointed, namely Mr Michael Van Koervedon, of CQT Services Pty Ltd. Michael is well respected for his past association representation on Standards Committees in the Quarry and Concrete related industries.

The Association has developed a working group to review specific aspects of the code/s. Various testing and data capture work is ongoing. Association members are encouraged to submit proposed amendments to AS3582.2, but note recommendations for amendment must be supported with published or available data.

Stage 6 - 'Engagement with BD031 Committee' Scheduled to commence in mid to late 2011, a series of committee forums for participants will be conducted. Working groups will table and discuss proposed amendments for each of the respective codes. These meetings will be facilitated by Michael Van Koervedon.

The aims for these committee forums will be to table proposed amendments, supported with data and to debate the merits of each proposed change. The review will also be considered by other government and industry specific codes and best practices where appropriate. The goal will be to gain consensus on proposed amendments prior to **Stage 7** - handover to Standards Australia.

Engagement will be conducted in an open transparent manner - so as to encourage a solutions based approach to improving the current codes, within what is achievable in the context of best industry practice.

Craig Heidrich

Newly Developed Reference Data Sheet from the ASA

A key aim of the Australasian (iron & steel) Slag Association (ASA) is to conduct research of common interest to members and present the findings and technical information to support the beneficial use of iron and steel slag. The Association has agreed to review the current guide to the use of iron blast furnace slag in cement and concrete. A number of recent key changes in the industry relevant to slag and slag products initiated the decision. These changes have resulted in users of concrete, component materials and other slag based products now requiring updated information on these products to allow the best outcomes of the material for design and constructional benefit.

Industry changes include:

- The sustainability debate and the role slags can play both as aggregates and supplementary cementitious materials
- The wider availability of neat milled slag for use as a SCM for concrete
- Changes to Australian standards for cements, SCMs, concrete and concrete structures
- New developments on VicRoads standard specifications

The ASA is currently in the initial stages of reviewing a "Guide to the Use of Iron Blast Furnace Slag in Cement and Concrete", and developing it into a series of five individual Reference Data Sheets (RDS) to provide relevant updated information for members.

These data sheets will include:

- **RDS 1:** Slag (Iron and Steel Blast Furnace): Aggregate and Cementitious Products
- **RDS 2:** Slag Aggregates: Properties, Characteristics and Applications
- **RDS 3:** Slag as a Binder for Concrete: Blended Cements, Supplementary Cementitious Materials and Mineral Additions
- **RDS 4:** Slag Binders and Aggregates: How they are Handled in Australian Standards
- **RDS 5:** Enhancing Sustainability with Slag Binders and Aggregates

Thus far in the project RDS 1 - Slag (Iron and Steel Blast Furnace) Aggregate and Cementitious Products, has been published on the ASA website. RDS 2 - Slag Aggregates: Properties, Characteristics and Applications, is in circulation among members of our technical committee for their input and feedback. The remaining three RDS will be developed within the next 6 months.

To download a pdf version of the newly developed RDS1 visit the knowledge section of the ASA website - www.asa-inc.org.au/knowledge. Each document will be available for download as they are approved. While in the knowledge section of our website, please take some time to view other related technical information made available by the Association.

The rut resistant performance of slag aggregates in pavements

A new development on the horizon for aggregate specifications is the introduction of a Repeated Load Triaxial (RLT) test (Figure 1) to measure the performance of basecourse aggregates for road pavements. "This test has been around for some time in research circles being able to simulate vehicle loading in the laboratory to predict the on road performance of an aggregate" says Dr Greg Arnold, managing director of Pavespec Ltd. Dr Greg Arnold completed his doctorate from the University of Nottingham, England in 2004 to develop an RLT test to predict the performance of aggregates and has continued his research in New Zealand assisting the New Zealand Transport Agency to develop a practical test and method of predicting performance in the road to assess the risk of early rutting failure (Figure 2) of existing and non-traditional aggregates such as Melter Slags.

Dr Arnold says "The Repeated Load Triaxial (RLT) test provides the opportunity to prove in the laboratory that alternative materials would work in the road without the need for road trials. All sorts of options are possible for developing alternative aggregates that will "do the job" on the road as a basecourse, but do not necessarily meet any traditional specifications.

On a more disconcerting note current aggregates complying with existing specifications may not stand up to todays heavy vehicle loadings. Despite all that effort to meet the basecourse specification requirements for grading, crushed faces, source rock durability, sand equivalent, and fines content the final aggregate mix may not have the necessary strength when wet and become blamed for early pavement failures. Aggregates get their strength from stone roughness and shape in terms of how they interlock and slide against each other. Existing specifications do not consider these factors. The RLT test is a measure of the aggregates performance and can determine with appropriate analysis whether or not it will survive with minimal rutting over the design life of the road. RLT tests can be conducted at different moisture contents to see whether or not an aggregate will fail if it gets wet.

Many RLT tests have been conducted on a range of different materials to determine their suitability as a road aggregate such as those from waste and recycled sources. Tests on Melter Slag aggregate in New Zealand and Australia show the performance is the same or better than traditional quarried crushed rock road base and it's use should not be restricted. In fact the performance of Melter Slag aggregate is superior to crushed rock when wet probably due to nil clay fines. Results are plotted in Figures 3 and 4.

(Dr Greg Arnold – Pavespec Ltd)

Figure 1.
Repeated Load Triaxial Test Equipment to Measure Rut Resistance to Aggregates.

Figure 2.
Early Rutting Failure of Granular Pavement.

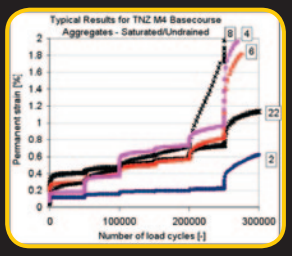

Figure 3.
RLT Results
(Note: low permanent strain indicates good rut resistance).

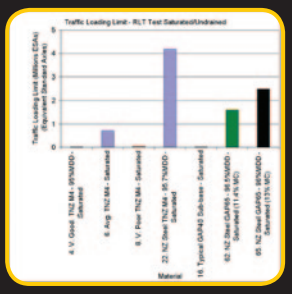

Figure 4.
Results of RLT Analyses in terms (Equivalent Standard Axles – 8.2tonne Dual Tyred Axle) to Achieve a 10mm Rut.

Company Members

A primary role of our Association is to bring together Slag Producers, Processors, Customers & Suppliers to the Slag Industry. Our activities cover technical developments, plant operations and processes, education and promotion. If you would like more information on the Association and how you can become involved, simply complete the information section at the end of this newsletter. Current membership is as listed.

Australian Steel Mill Services Pty
BIS Industrial Logistics
Boral Cement Ltd
Bluescope Steel Ltd (Port Kembla)
Cement Australia
Concrite Pty Ltd
CSIRO
HiSmelt Ltd
Holcim Pty Ltd
Holcim NZ Ltd
Harsco Metal Holdings Pty Ltd
Monash University
New Zealand Steel Minerals
OneSteel Limited
Roads & Traffic Authority of NSW
SCE (Steelstone)
Steel Cement Ltd
Swinburne University of Technology
University of Newcastle
University of Queensland
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Gregory, G
Hanley, P (Hon.)
Heaton, B (Hon.)
Hinczak, Dr, I (Hon.)
James, W (Hon.)
Jones, D E (Hon.)
Prosser, S D (Hon.)
Venour, M (Hon.)

Related Associations - Canadian Slag Association | National Slag Association (US) | Nippon Slag Association (Japan) | European Slag Association (EU)

Slag Roadbase case studies

Airport Runways

During the planning of Sydney Airports 3rd runway, ASMS proposed a slag blend consisting of 80% ABFS and 20%GBFS by volume as a sub-base for runway construction. This blend had already exhibited excellent field performance and following extensive trials and additional testing, Australia's Federal Airport Corporation recommended slag materials be used for the project.

During the design phase, where assumption of structural stability is required, the slag pavement layer was considered to be flexible, although cores obtained from a trial pad 20 months later exhibited Unconfined Compressive Strength (UCS) results from 6-10MPa. The project was completed in 1994 and after 6 years of service, Sydney Airport Corporation, reported the actual pavement deflections were significantly lower than design and no significant pavement cracking has been observed.

The third runway at Sydney Airport contains over 250,000 tonne of slag blend and is still performing beyond design expectations. Since completion of the 3rd runway, Sydney Airport Corporation have utilised a further 200,000 tonne of slag blended roadbase material for several projects, including the recent taxiway widening to accommodate the Airbus A380.

Highways and Freeways

In the southern region of New South Wales, the Roads and Traffic Authority designs many bound pavements to highway loading requirements. The ASMS blended slag roadbase containing 80% ABFS and 20% GBFS is suitable for these applications and this roadbase stabilised with a 2% binder has been used extensively in the region for the past 10 years. During this time, more than 500,000 tonne of slag blend roadbase has been used in major road projects, including; the North Kiama by-pass, the Princes Highway re-alignment at Dunmore, the Northern Distributor extension through to Bulli and more recently, the Picton Road safety upgrade.

Council/Locally Trafficked Roads

Many council roads require the use of flexible roadbase materials and to meet this need, ASMS developed slag/basalt blends incorporating basalt fines from local quarries. The product conforms with Council and NSW Roads and Traffic Authority (RTA) specifications and over the years has been used by many nearby councils, including; Wollongong, Wollondilly, Wingecarribee, Shellharbour, Shoalhaven, Liverpool and Campbelltown.

Figure 1- Dunmore

Figure 2- Kiama By Pass

Figure 3- The Northern Distributor

Figure 4- Port Kembla Steel Works

The regenerative frictional properties of slag aggregate

It has been accepted by many road authorities in the UK that steel slag asphalt has provided a good level of skid resistance throughout the life of the surfacing. Long term monitoring of the frictional properties of these materials using SCRIM (Side-ways Force Routine Investigatory Machine) and Grip testing has supported this, providing values above the minimum investigatory level without any significant drop in performance.

In an attempt to gain a better understanding of this phenomenon, the University of Ulster (a leading authority on road stone interaction) was commissioned by Harsco Metals to investigate a variety of iron and steel making slags from Harsco sites around the world. This is comprised of two EAF slags from the UK and one from Australia, one BOS slag from The Netherlands, one stabilised AOD stainless slag from the UK and one Melter (iron) slag from New Zealand.

The testing protocol involved a series of standard tests to evaluate the general physical and mechanical properties of the slag aggregates in order to compare them with similar quality aggregates on the university database. The results of this stage of testing concluded that all the slags were equivalent to the natural aggregates on the universities database of approved materials for surface course materials in the UK. However, all the slags proved to be more resistant to fragmentation than natural aggregates and the resistance to wear, under both wet and dry conditions, was found to be much better than the majority of higher PSV (polished stone value) aggregates used in the UK.

The next stage of testing consisted of a series of non-standard tests, designed to subject the aggregate to extreme stress, in relation to polishing, but also to assess the effect of environmental conditions associated with natural weathering i.e. rainfall and dry spells etc.

Polishing Stage

Three polishing regimes were carried out on standard 6/10 mm samples of all the slag types used for the project. These took the form of extended polishing time and also aggressive sideways polishing with an offset wheel at sixty (60).

The data shows each slag to have lost between 17 to 27% of its unpolished skid resistance during the standard six (6) hour PSV test. Extended polishing was found to further reduce skid resistance by between 5 to 12%.The results of the additional period of intense stressing reduced the values to between 52 to 65% of the standard PSV. All slags performed differently to each other but also under different polishing regimes.

Weathering Stage

Three regimes of varying degrees of wetting and drying were used for this stage of tests.

Repeated wetting and drying resulted in all slag types recovering skid resistance values above the standard PSV after extended polishing. AOD showed a dramatic recovery of around 70% above the standard PSV.

Air drying provided a lesser recovery of between 12% and 22% of the standard PSV.

Even after the extended aggressive polishing the slags skid resistance value recovered to between 68% and 87% of the standard PSV. Further soaking showed that the slags recovered an average of 97% of the standard PSV.

Conclusion

All six (6) samples of slag recovered wet skid resistance in all 3 post polishing regimes and the trend continued upwards at the end of all test regimes. This does not happen with natural aggregates.

The result of this study demonstrates the low abrasion and prolonged skid resistance of steel making slag aggregates, thus improving the safety of roads for longer and prolonging the life of the road, ensuring cost effective solutions for the highway authorities.

Nick Jones- Harsco Metals Group Limited

Sustainability Victoria Program comes to successful conclusion

Focusing on building the capacity of the Victorian steel industry and supply chain partners to develop new products and enhance existing product opportunities for EAFS. The association has completed the final milestone for the "Sustainability Capacity Building Program" supported by Sustainability Victoria after some eighteen months of working with Victorian based members.

The program has successfully achieved its aims, which broadly contribute towards the associations aims of increasing the effective utilisation of iron and steel slag (ISS). Some 34 companies were involved in activities and discussions, assessing several new low-carbon product opportunities and their application which lead to the following positive outcomes (all available for download on the Associations website):

- **Engagement survey report**
- **Benchmarking report**
- **Case study: Low carbon product opportunities in the EAFS supply chain**

Sustainability Victoria acknowledged the program has increased connections and changed attitudes within the Sustainability Capacity Building Program Group. There has been an improvement in the understanding of opportunities/issues and a development of products facilitated. Supply chain links have been strengthened and the identification of opportunities expanded.

Whilst participants recognised the importance of the differences in operational environments across the supply chain and also indentified where and how to best influence change, the challenge now is to reflect on Dr. Woodheads' comments '...successful change still requires a commitment to explore and challenge assumptions about business as usual'.

Copies of the benchmarking survey, and case studies can be downloaded from the association website at www.asa-inc.org.au.

Niribi Charker

AUSTRALASIAN

Alison Fitzgerald, Marketing Coordinator

Alison Fitzgerald (pictured) has recently begun her second year of study at the University of Wollongong. She is undertaking a Bachelor of Media and Communication, majoring in Advertising and Marketing and will be taking up where Mona Forghani left off in December 2010. She has assumed the part- time position of Marketing Coordinator and is very eager to apply her current degree and skills to her work at HBM Group.

Concrete Institute Conference 2011

The Concrete Institute of Australia's 25th Biennial Conference will be held in Perth, Western Australia, from Wednesday 12 October to Friday 14 October 2011. We are pleased to be able to announce some special features which will make this a great conference for attendees, participants, exhibitors and sponsors. Details of the conference program and papers can be found at http://www.concrete2011.com.au/.

INTERNATIONAL

The 7th Global Slag Conference returns to the Northern Hemisphere. This year it will be held in Scandinavia for the first time, in Helsinki Finland. Dates to add to your calendar are 17-18 November. Further details are available through the Global Slag website at www.propubs.com/gsc.

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