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THIS QUARTER:

association Connections

THE AUSTRALASIAN SLAG ASSOCIATION NEWSLETTER

Ecologically Sustainable Development – the key to our planet's future.

MUCH has been written and spoken, about the environment and the impact of human activity. In all of this, there are extremes of view, from those who would believe that the world is in imminent danger of destruction through global warming, through to those who want to debate the science underpinning such claims. Whilst we may debate global warming, there is no doubt that human activity does have an impact. There is a greater appreciation of environmental impact of human endeavour at least in the developed countries. The notion of Ecologically Sustainable Development (ESD) emphasises that there must be a balance between human activity and the longer term impact on the planet.

In this issue of Connections, the articles showcase slags success in construction applications, whilst contributing to Ecologically Sustainable Development (ESD). The recent Concrete Institute of Australia (CIA) conference – Concrete '99 reviewed in this edition chose as its theme *"Our concrete environment"*. Papers outlined implications of sustainable development for the concrete and construction industry.

For quite a number of years now, the benefits of using high slag cements to enhance the durability of structures has been recognised. One of the most recent examples, the Sydney Airport Link Tunnel received the coveted Kevin Cavanagh Medal Award from the CIA for excellence in Concrete Structures.

By definition, slag is *"the more or less completely fused and vitrified matter separated during the reduction of a metal from its ore"*. Our article "Slag's ain't Slag's" sets out to explain the range of products that fit under this generic term. Whilst most written material is about slags from the production of Iron and Steel, the article identifies other industries which also produce slags.

Innovation is no stranger to the Slag industry. Recent research on alkali activation of ground granulated slag has yielded promising early strength results. Solutions proposed by this work are more practical than those usually offered the activation of cementitious materials without the use of Portland Cement.

A new granulation facility at Port Kembla replaces capacity lost with the closure of primary production at Newcastle and provides for growth of the slag cement market.

EDITORIAL

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Slag cements airport tunnel – another successful application

L to R: Dick Barker (ACH), Denis Cunneen (TBJV), Shaun Clarke (ACH), Peter Twomey (TBJV), Kathy Jones (TBJV), Alfredo Bustos-Ramirez (TBJV), Norm Nolan (ACH), Andrew Marsonet (TBJV), Peter Shea (ACH), David Mahaffey (Mahaffey Associates), Ian Wallace (TBJV).

TRANSFIELD BOUYGUES Joint Venture the designer and construction company for the Sydney Airport Link, will complete 10 kilometers of underground railway with four underground stations located between Central Station and the East Hills Line early in the year 2000. This will also provide the much needed connections between the Domestic and International Air Terminals.

Valued at over $700 million the project represents another fine example of the suitability of slag cement to very stringent criteria for concrete performance. Slag cement was used to manufacture 24,600 tunnel segments for construction of the 6 km of tunnel lining through the southern soft-ground section.

The tunnel segments must withstand exposure to many ground environments, including saline ground water and organic matter. Given the aggressive sediments a blended

continued back page

Slag's ain't Slag's

IT has long been held by many that the term slag means ìthat stuff that comes out of a steel worksî. Slag can come from many sources and be produced in many shapes and sizes. The chemistry and morphology of a

particular slag depends on the metal being produced and the solidification process used.

Slags can be broadly categorised as ferrous (iron/steel) and non-ferrous (copper, lead/zinc) depending on the industry from which they come.

Described below are the main types and uses of slag commercially available in Australasia.

PRINCIPAL SLAG TYPES

Iron Blast Furnace Slag (BFS)

This is the by-product from the reduction of iron ores to produce molten iron and molten slag. The slag is normally treated in two ways:

1. By placing the molten slag to ground bays and air-cooling to a crystalline rock form; this is known as Air-Cooled Blast Furnace Slag, which is a light grey vesicular rock.
2. By passing the molten slag through a sufficient water stream in a granulator to ensure the slag is broken up to become a glassy, sand-type material, known in the industry as Granulated Blast Furnace Slag. The colour of this product is very similar to normal beach sand.

Basic Oxygen Steelmaking Slag (BOS)

This is more commonly known as Steel Furnace Slag. This slag is formed when molten iron, scrap metals and various fluxes, such as lime, are oxidised by injecting large amounts of pure oxygen into the molten iron mix to create steel and slag.

The slag produced is generally placed into ground bays, similar to that in the ironmaking process, and then air-cooled.

Electric Arc Furnace Slag (EAF)

Also often referred to as Steel Furnace Slag. This slag is produced when scrap metal and fluxes are oxidised by the use of an electric current. As with BOS steel furnace slag, the slag is generally placed into ground bays for cooling. Both BOS and EAF slags are somewhat heavier than Blast Furnace Slag and naturally-occurring rock.

Copper Slag (CS)

This is a non-ferrous slag, produced by the reduction of ores and fluxes into copper and slag. This slag is generally granulated as described earlier. This slag is very glassy in appearance and is a dark colour and generally single-sized at about 2mm when granulated.

Lead/Zinc Slag (LZS)

Also non-ferrous, this slag is the by-product of Zinc smelting. The slag is generally treated in the same manner as Granulated Iron Blast Furnace Slag, by passing it through a water stream to produce a sand size product with a top size of about 5mm, with only a small quantity of material below 1mm. This slag is very dark in colour and has attracted the name of Black Sand.

COMMON USES FOR SLAG

Below is a short description of the common uses of slag products in Australia.

Air Cooled Iron Blast Furnace Slag

In uncrushed form uses include; fill and embankments (particularly areas subject to severe loading such as mainline rail systems), construction of working platforms on difficult sites. In some areas uncrushed slag is also used for pavements, where binding fines are produced by rolling to break the slag down to fill the voids.

As a graded roadbase. It can be used on its own, blended with other slags and/or with other natural rocks and sands.

Crushed and graded, uses include; concrete aggregates, concrete sand, glass insulation wool, filter medium, and use under concrete slabs as a platform.

Granulated Iron Blast Furnace Slag

The principal use is as Cement enhancement (when ground). Normally it replaces 30-40% of Portland Cement, but can replace up to 70% in specialist applications such as marine concrete.

Other uses include; glassmaking as a furnace flux, trace elements in agriculture, concrete block manufacture, sporting field sub-base (for drainage), filtration medium, reinforced earth embankments, and mine backfilling. Granulated slag is also an efficient grit-blasting medium for fine etching.

Basic Oxygen and Electric Arc Steelmaking Slag

BOS Slag can be blended with many other materials, as described for BFS, to obtain a suitable pavement material depending on location. A BOS typical slag roadbase blend can include granulated slag, fly ash and lime.

Other uses for BOS slag include, rail ballast, asphaltic concrete aggregate, soil conditioner (due to its free lime and trace elements) and construction fill, provided it is not a rigidly confined.

Copper Slag

The main use for copper slag in Australia is in grit blasting, due to its sizing and strength characteristics.

Lead/Zinc Slag

As concrete sand (Black Sand), this material is mostly spherical in nature and its replacement of natural sand in concrete reduces the water demand for a given mix.

Remember *"Slag's ain't Slag's"*. So next time you come across a reference to slag, make sure the article clearly indicates just what type of slag is involved. You will be surprised at just how often an Author assumes that you know. For further information on any of the above slag products, please contact the Australasian Slag Association.

Concrete '99

our concrete environment

The 19th biennial conference of the Concrete Institute of Australia continued its tradition of offering topical and informative conferences for concrete practitioners.

The environmental issues were of special interest to all delegates, with a number of speakers presenting on ESD and concrete structures. These papers outlined implications of sustainable development for the concrete and construction industry, measures being taken by the Australian cement industry to mitigate greenhouse gas emissions and the state of the art in producing green concrete in Denmark.

In-line with the ASA's charter to educate and inform users and specifiers of the benefits from the utilisation of slag products, we conducted an information stand to compliment the thrust of the CIA's conference topics. It was well attended with general inquiries regarding slag and its various uses. One point of key interest was the changing attitudes towards developing sustainable industries which combine materials that support ESD principles.

ranulation of more iron blast furnace slag directly impacts the quantity f rock slag produced. The long term proportions of granulated and rock ag produced, will be determined by market demand.

New Granulator at Port Kembla supports the Slag for Cement Industry

THE CLOSURE of Ironmaking at Newcastle Steelworks later this year has necessitated a review of Granulated Slag Production Facilities at Port Kembla. Australian Steel Mill Services has committed the required capital to install a Paul Wurth Inbar granulator, adjacent to the No.6 Blast Furnace. Initially, this will take up the approximately 200 000 tonnes of granulated slag produced each year by BHP Newcastle and will allow capacity to grow with the market, particularly for slag cement production.

This initiative allows a balanced production of granulated and rock slag from No.s 5 and 6 Blast Furnaces at Port Kembla. Granulation of more iron blast furnace slag directly impacts the quantity of rock slag produced. The long term proportions of granulated and rock slag produced, will be determined by market demand.

Ensuring that all of the iron blast furnace slag is used beneficially in either rock or granulated form, makes a strong contribution to the environment, consistent with ESD principles.

For further information please contact Geoff Roberts at ASMS.

Stonnington City Council
Thinking Globally and Acting Locally

WHEN the 1992 United Nation's Conference on Environment and Development (UNCED) preparatory process began, the operative principle was that national governments, multinational corporations and international non-governmental organizations were the key decision-makers and problem solvers that would be able to set us on the road to sustainable development. But when UNCED's culminating document, Agenda 21, was finally approved, recognition was given to the critical importance of local action and locally based solutions. An excellent example of "think globally, act locally".

An example of local action and locally based solutions can be found in a recent tender document forwarded to the Associations office by Independent Cement & Lime, based in Melbourne. The Stonnington City Council has committed to including specific reference to energy resources and the efficient utilisation of materials under project requirements.

Council specifies that the contractor must determine the optimum use of natural/existing resources *"The cementitious component of the concrete shall contain a proportion of by-product material such as Flyash, Blast Furnace Slag (BFS) and/or Silica Fume (SF), as part of the mix design." (extract from Tender Document)*.

Local communities, which Councils serve, are rapidly becoming environmentally aware, and this trend will only continue to accelerate. Our industry Association has a duty to continue to inform and educate both users and specifiers of the benefits of using appropriate slag products in-support of these objectives.

We look forward to the next tender, which specifies slag products as an essential component of its contract requirements and supports the initiatives of Agenda 21.

Excellence in Concrete – *25 MPa in 24 hours.*

TRADITIONALLY, slag blended cement's have little application in high early strength construction due to a slower rate of strength development than other types of binders. Nevertheless, slag blended cements offer a low heat of high duration and good durability.

A recent project carried out by Monash University, has investigated the feasibility of making high-quality structural concrete with alkali-activated slag concrete (AASC), based on 100 percent slag binder. It has demonstrated that high early strength of (25MP in just 24 hours) high-performance AASC can be successfully produced. The high early strength was achieved without using any special curing techniques, such as stream curing. Unlike previous overseas investigations, the activator was based on powder so it can be dry pre-blended with slag, avoiding occupational health and safety issues associated with handling and dispensing of liquid alkali's at the mixing plant. Other aspects that were investigated included workability, effects of curing on strength and shrinkage, comparison of laboratory AASC with AASC made at a concrete mix plant, insitu strength, shrinkage under restrained conditions, use of air cooled slag as coarse aggregate in AASC (thus producing 100 percent environmentally green concrete), and occupational health and safety issues.

Company Members

Our *Association's role is to bring together Slag Producers, Processors, Customers and Suppliers to the Slag industry. Our activities cover Technical Developments, Plant Operations and Processes, Education and Promotion. If you would like more detail on the Association, and how you can be come involved, just complete the information section at the end of this newsletter. Current membership is as listed below.*

- *Australian Cement Ltd*
- *Australian Steel Mill Services Pty*
- *Australian National Industries (ANI Comsteel)*
- *BHP Integrated Steel Div (Port Kembla)*
- *BHP Rod Bar & Wire Products Div (Newcastle)*
- *Blue Circle Southern Cement Ltd*
- *Boral Concrete & Quarries*
- *Brambles Equipment*
- *Brambles Industrial Services (Whyalla)*
- *Cleary Bros (Bombo) P/L*
- *CSIRO*
- *CSR Readymix Group*
- *University of Wollongong – Dr Denis Montgomery*
- *Finlay Screens*
- *Gough & Gilmour*
- *Heckett Multiserv (UK)*
- *Heggies Bulkhaul*
- *Kress Corporation*
- *Mahaffey Associates*
- *Metserv Australasia Pty Ltd*
- *Milburn New Zealand Ltd*
- *Mountain Industries P/L*
- *University of Newcastle – Mr Brian Heaton*
- *Nichimen Australia Limited*
- *NS Komatsu*
- *Pioneer Construction Materials*
- *Premium Tyre Service P/L*
- *Queensland Cement Ltd*
- *Roads & Traffic Authority of NSW*
- *Slag Cement Sdn Bhd, Malaysia*
- *Smorgon Steel*
- *South Coast Equipment*
- *SsangYong Cement (S) Ltd, Singapore*
- *Steel Cement Ltd*
- *Steelstone Services (Aust)*
- *Sulphide Corporation P/L*
- *The Slag Reduction Company (NZ) Ltd*
- *UBE Industries Ltd*
- *Wormald Fire Systems*

Personal Members

- *Anderson L*
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- *Dobson G*
- *Haber E W*
- *Jones D E*
- *Maric M*
- *Marosszeky M*
- *Prosser S D*
- *Reeves C M*

Related Associations

- *National Slag Association*
- *Nippon Slag Association*

continued from cover story

airport tunnel

slag cement "Ocean Cement" was provided by Australian Cement for the project.

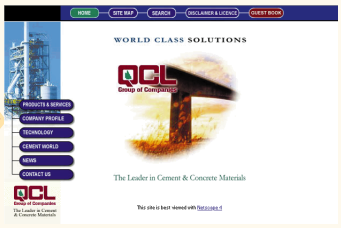
Low drying shrinkage combined with good compressive strength and resistance to sulphate acid attack were the key considerations in selecting "Ocean Cement". More than 30,000 tonnes of it has been used to make 78,000 cubic metres of concrete.

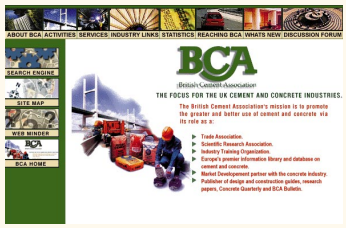
The segment manufacturing process utilized a batching, casting and transfer system with the segments passing through an autoclave held at an operating temperature of 55 degrees in a humidity controlled environment at 70% constant. After passing through the cycle process of approximately 6.5 hours the segments would exit with a compressive strength of approximately 12 MPa.

In recognition of the technical achievements in the construction of the Sydney Airport Link Project, Transfield Bouygues were awarded the coveted Kevin Cavanagh Medal Award by the Concrete Institute of Australia (CIA) for excellence in Concrete Structures.

For further information contact **Peter Shea on (02) 9395 1500** at Australian Cement.

Sites of the Month





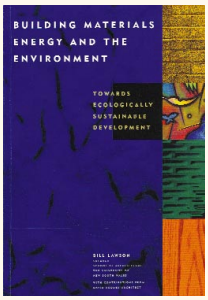
BOOK review

Building materials energy and the environment – Towards Ecologically Sustainable Development (ESD).

Recognising that Architects and Builders can make a real contribution towards Ecologically Sustainable Development, the University of New South Wales – Solarch Research unit has developed a book to guide in the choice of materials and design. In making the case for ESD the book states: *"It is no longer enough to design and build the future, we must also design and build for the future. For our long-term viability there is really no alternative."*

"Building Materials, Energy and the Environment: towards ecologically sustainable development" describes the environmental impacts of building materials and quantify the energy consumed in the production of common floor, wall and roof assemblies.

It is of great value to architects and building technologists attempting to reduce the environmental impacts of their work; and is similarly of interest to prospective clients–from large developers to suburban homeowners. It is also suitable as a text for architecture, building and related courses.



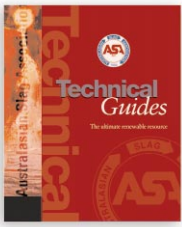
The book has been authored by Bill Lawson from Solarch at the University of New South Wales, with contributions from David Rudder. It is written in an easy to read style, is well referenced and contains an illustrative series of case studies.

For further information contact The Royal Australia Institute of Architects (RAIA) on the 02 6273 1953.

Advertising

Slag – "the ultimate renewable mineral resource" video has proved to be a favourite with many members. A considerable amount of new additional footage has been incorporated demonstrating the beneficial properties of slag in various large-scale projects completed in recent years. The video (15mins duration) outlines slag's historical beginnings through to the various types of slag produced in a modern production process today.

Since our last issue we have had to produced another 100 copies to meet further demand. Copies are available to members at a cost of $15.00 each, non-members $20.00 plus postage and handling. Just complete and fax back the subscription/order form indicating your requirements.



Given the number of high quality guides the ASA has produced, and continues to produce (i.e. new -"Guide to the Use of Steel Furnace Slag in Asphalt and Thin Bituminous Surfacings") together with bulletins, newsletters and general correspondence, the Education and Promotion Committee have developed a Technical Compendium for the purposes of storing these important documents and more.

The Compendiums are an invaluable reference tool for engineers, specifiers, consultants, government authorities, and various slag users. Copies are available to members at a cost of $15.00 each, non members $20.00 plus postage and handling. Please note that as amendments are made to the contents of the compendiums, registered holders will receive updates. Just complete and fax back the subscription/order form indicating your requirements.

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