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ASSOCIATION

connections

THE AUSTRALASIAN SLAG ASSOCIATION NEWSLETTER

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THE AUSTRALASIAN SLAG ASSOCIATION NEWSLETTER

Editorial comment

Iron and Steel slag products have a long history of use in Australia and internationally. Early Australian projects often used unprocessed or partly processed material that was compacted directly into the road bed using equipment that provided some breakdown of the larger particles as well as achieving the desired profile and compaction level. This generally meant that slag products were used in close proximity to an iron and or steel producing facility including Mittagong, Lithgow, Newcastle, Port Kembla, and Whyalla and for some period Kwinana in WA.

Increased traffic volumes, heavier axle loads and the development of freeways and major highways over the past 25 years has brought about significant changes in design and construction techniques,

requiring different materials delivering predictable performance and pavement lives. Major road networks have also moved well beyond the neighbourhood of the slag production centres.

In the quest for better road service life, the NSW Roads and Traffic Authority (Previously Department of Main Roads) conducted major trials during the 1980's using an Accelerated Load Facility (ALF) on existing pavements and in a major trial at Prospect. This procedure enabled the delivery of a pavement life of axle loads in a very short space of time and influenced changes to design criteria and specification of materials. During the *Prospect ALF Trials* the technical competence of slag pavements was demonstrated.

Slag products have been developed since this time

to meet a range of pavement designs and construction techniques from unbound, lightly bound to heavily bound pavements, through to products for in pavement stabilisation both new and reconditioned as well as road surfacing materials.

Since iron and steel slags are formed as 'molten rock' co products the potential exists to impact on the cooling regime to produce a range of products specifically targeted at end markets. Once solidified, the slag products are processed using conventional crushing, screening and grinding plants.

This issue of *Connections* provides an overview of iron and steel making slags in pavement construction and provides examples where the versatility and range of slag products is demonstrated. ■

Versatility of iron and steel making slags in pavement construction

Slag, the co product of the production of iron and steel has a long history of use in pavement construction from early roman roads through to modern high use airport runway and highway pavements. Physical properties of Typical Blast Furnace Rock and Steel Slags are shown in Table 1.

Molten slag separates from molten iron at around 1500°C. Allowed to cool slowly, the slag forms a vesicular rock material able to be used in a number of ways to produce quality pavements. Rapidly quenched the molten slag transforms to granular sand like material having structural and stabilising properties.

Steelmaking slag is slow cooled to form a dense rock material suitable for a range of pavement applications.

Both blast furnace slag and steel slag have been used in pavement construction as Engineering fill (including select subgrade), Sub base, Base and Stabilisation.

Engineering fill (including select sub grade)

Blast furnace rock slag in the uncrushed form produces a very stable high shear strength platform when compacted due to the high degree of mechanical interlock of the vesicular material; further aided by the self cementing of the fill that develops slowly over time.

Blast furnace granulated slag can be used as a fill material. Because of its sand like texture it is easy to work. Its

self cementing properties cause it to set up over time. **Steel slag (BOS & EAF)** used uncrushed it develops good material interlock. The free lime available can assist in stiffening sub grades by lime stabilisation and can combat acid sulphate soils.

Sub base

Blast furnace rock slag processed by crushing and or screening produces potentially self cementing sub base materials that can achieve stiffness equivalent to a heavily bound pavement within 12 months.

Granulated blast furnace slag sets up more rapidly sets more rapidly than rock slag so that from about 3 months it will resemble a coarse sand cement mortar with an Unconfined Compressive Strength of around 5 MPa.

BOS slag can produce a range of stabilised pavements using a range of blends individually and in combination with a range of activators including fly ash granulated slag and power station bottom ash.

EAF slag has been used successfully as a crusher run, blending with in situ materials or blast furnace slag

Base Course

Blast furnace rock slag processed by crushing and screening produces a range of pavement materials from air runway sub pavements to highway city and suburban roads. These have been well proven over many years.

BOS slag blended with other materials bound pavements have been produced having a 28 day damp Unconfined Compressive Strength of 5 MPa.

EAF slag has been blended with other pavement materials at around the 40% level to increase the wet/dry strength of the pavement material and reduce plasticity.

Granulated slag is a suitable binder for a range of pavements designed by French road pavements called grave latier.

Stabilisation

Various slag binders are available for the chemical stabilisation of soils, gravels and crushed rock. The versatility of products available allows longer haul times and distance, the ability to trim and rework pavements and improved rideability through increased working times that allow better finishing.

More detailed product information, test results and case studies are available in the publication *A Guide to the use of Iron and Steel Slag in Roads - 2003* available from Australasian Slag Association. ■

PHYSICAL PROPERTY — AGGREGATE		BLAST FURNACE SLAG	STEEL SLAG		TEST METHOD
		ROCK SLAG	BOS SLAG	EAF SLAG	
Particle density (kg/m3)	Dry	2,450 — 2,550	3,300 — 3,400	3,300	(AS1141.5 & 6)
	SSD	2,550 — 2,650	3,350 — 3,450	3,400	
Dry strength (kN)		85 — 100	275	250	(AS1141.22)
Wet strength (kN)		65 — 90	230 — 300	240 — 300	
Wet/Dry strength variation (%)		10 — 20	5 — 20	5 — 15	
Water absorption (%)		4 — 7	1 — 2 coarse	1 — 2 coarse 2 — 4 fine	(AS1141.5 & 6) 2 — 4 fine
LA abrasion		37 — 43	12 to 18	16	(AS1141.23)
Polished Aggregate Friction Value (PAFV)		N A	58 to 63	58 to 63	(AS1141.41/42)
Sodium Sulfate Soundness (%)			<4	<4	(AS1141.24)
PHYSICAL PROPERTY — ROADBASE					
Maximum Dry Density (kg/m³)		2,050 — 2,150	2,300 — 2,400	2,300 — 2,400	(AS1141.5.1.1)
(20mm GMB Standard Compaction)					
Optimum Moisture Content (%)¹		8 — 12	8 — 12	8 — 12	(AS1289.2.1.1)

Table 1: Physical Properties of Typical Blast Furnace Rock & Steel Slags

Note: ¹OMC depends on the components of the mix.

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"The Australasian industry is part of a wider international fraternity of slag product manufacturers, marketers and users."

Slag Road bases: Cost Savers

For further information contact Vijay Joshi – ASMS: 02 4276 2288

Slag, a co-product of iron and steel manufacturing process, has a number of engineering application out of which its use as a roadbase material is predominant. In Australia, slag roadbase has been introduced into roads (base, subbase and subgrade enhancement) more than 70 years ago. However, it is only last decade that this particular application of slag has gained widespread recognition and acceptance among road making authorities. This is due to the facts

- Slag materials meet road making specification and,
- Slag materials are considered as cost savers

At Port Kembla, 100kms south of Sydney, Australian Steel Mill Services (ASMS) process and market more than 1.8 million tonnes of slag per year. There are three types of slag:

- Blast Furnace Slag (BFS)
- Granulated Blast Furnace Slag (GBFS)
- Steel Furnace Slag (SFS)

BFS and GBFS are from iron manufacturing while SFS is from steel manufacturing. All three types of slag contain Calcium Oxide and as such slag products are self-cementing. ASMS have developed various slag blends to meet road-making specifications. Products and their applications with particular conforming specifications are tabulated in Table 1.

All these products have maximum dry density

PRODUCTS	PRODUCT CODE	APPLICATION	SPECIFICATION
Slag DGB20	RBU100	Base & Subbase	RTA Spec 3051 (flexible pavements)
Slag 80:20	RBU800	Base & Subbase	RTA Spec 3052 (bound pavements)
Modified Slag 80:20	RBM800	Base	RTA Spec 3052 (bound pavements)
Slag Subbase	ABF222	Subbase	Non specified
Crusher Fines .6mm BFS	ABF200	Subgrade enhancement	CBR more than 60

Table 1

(M.D.D) in the range of 2.00 to 2.10t/ms. This MDD value is at least 10% lower than competitive Roadbase materials leading direct cost saving. Another cost saving can be achieved in the field. The slag products reach its 100% compaction in just 6-7 passes of roller compared to 8-10 passes of the same roller for other materials. This significant cost saving is achieved without any compromise or relaxation in the specification.

The cost saving fact have been recognised by

various contractors for their different projects. The most recent projects are shown in Table 2.

ASMS also supplies more than 100,000 tonnes of steel slag and 25,000 tonnes of GBF to Newcastle Area/Hunter Region where slag is blended to meet RTA Specification.

These examples are self explanatory exhibits for slag roadbases are cost savers without compromising a quality or road making specification. ■

CONTRACTOR	AUTHORITY	PROJECTS	PRODUCT	APPLICATION
TRN	Camden Council	Narrelan Subdivision	RBU100	Base Course
TRN	Wingecarribee Council	Moss Vale Subdivision	RBU800	Base Course
Coastwide	RTA	F 6 Freeway intersection Yallah	RBU800	Base Course
RTA	RTA	Kiama bends, Kiama	RBM800	Base Course
Stabilised Pavements	RTA	Oran Park	RBU800	Subbase and Base
Stabilised Pavements	RTA	Luddenham Intersection	RBU800	Subbase and Base
Western Earth Moving (WEM)	Campbelltown Council	Campbelltown Subdivision	RBU100	Base Course
Natcon Construction	Shellharbour Council	Shellcove Subdivision	RBU100	Base Course

Table 2

Performance of GB Cements in pavement stabilisation

Although Stabilisation plays an important part in the construction and maintenance of road and other pavements in Australia, and although GB Cements are the most widely used binder additives, there is still a lack of knowledge and understanding of the properties of GB Cements in their use in stabilisation.

There has been much anecdotal information from past experience using GB (General Purpose Blended) Cements. There have also been a number of research activities involving GB Cements as a part of wider investigations of stabilisation binders.



One problem with some of this previous research is that its scope has been so broad that it has not been able to properly identify the characteristics of the performance of GB Cements in their use in the pavement stabilisation sphere.

With this in mind, Stabilised Pavements of Australia Pty. Limited set up a detailed research testing programme in co-ordination with Brisbane City Council. This testing programme was specifically designed to be both detailed and focused in an effort to obtain



clear and definitive information on the performance of GB Cements in pavement stabilisation work.

In summary, cement stabilisation is a cost effective, quick and easy method of pavement construction and/or reconstruction with significant environmental advantages. **The use of GB Cements in lieu of GP Cement increases the cost savings, quality and environmental benefits.**

By testing in detail three different road making materials from Brisbane City Council which represented a reasonably wide range of variance for pavement materials, the performance properties for the four most commonly available GB Cements were able to be accurately assessed.

The extra working time available using all GB Cements in stabilisation work is a considerable benefit in terms of reducing costs further; through the ease of attaining quality levels and increasing practical production rates. Again, these advantages of GB Cement are slightly more pronounced for the higher slag content blends, e.g. 60/40 Slag/Cement.

The information gained in terms of Shrinkage was interesting in that it supported earlier evidence that the shrinkage is determined by the nature of plastic fines in the pavement material and that the addition of cementitious products actually reduces shrinkage.

The use of all GB Cements is of considerable benefit to the environment and the community. The replacement of some of the Portland Cement by flyash or slag decreases the demand for the manufacture of cement.



In conclusion, the use of any GB Cement in cement stabilisation work is usually of benefit for a number of reasons as outlined above, with slightly greater benefits, for the higher percentage slag blends. Through an understanding of the performance properties of GB Cements and assessing other factors including commercial viability, practicality and specific job requirements, an informed decision can be made on a suitable selection for an appropriate GB [Blended] Cement.

The full paper is available in the ASA on line library at: www.asa-inc.org.au ■

Extracted from the paper Detailed Investigation of the Performance of GB Cements in Pavement Stabilisation by Warren Smith & Bruce Hansen.





Versatile Pavements from Illawarra

The versatility of iron and steel making slags as road building materials is demonstrated by the projects on this page.

For further information contact Vijay Joshi – ASMS: 02 4276 2288



Northern Road Intersection

Location: Northern Road Intersection of Northern Road and Elizabeth Drive Luddenham NSW
Application: Base course lightly bound pavement (RTA Spec 3052)
Contractor: Stabilised Pavements P/L
Client: Roads and Traffic Authority of NSW

This road starts from Narellan and joins MR 9 at Penrith. It carries heavy vehicle movements including B-Doubles. On geotechnical advice the subgrade (CBR 3 to 6) was stabilised as a basecourse using slag 80:20 (RBU800), being used in the new lane under construction and at the roundabout.

Appin Road Rosemeadow

Location: Appin Road, Rosemeadow NSW
Application: Base Course Bound Pavement (RTA Spec 3052)
Contractor: Roads and Traffic Authority of NSW
Client: Roads and Traffic Authority of NSW

Appin Road connects Port Kembla and Campbelltown NSW. This is a road carrying high volumes of traffic, passing adjacent to significant residential development in the South Campbelltown area. It is also a heavy haul road servicing the collieries near Appin. Chosen for this project was slag RBM800, the addition of 2% binder meeting the long-term performance criteria whilst allowing the road to be trafficked the following day – a significant advantage.



Campbelltown Link

Location: Campbelltown link project
Application: Flexible pavement – Base course (RTA Spec 3051)
Contractor: Western earthmoving P/L (WEM)
Client: LANDCOM

This is another of the LANDCOM residential subdivisions. Material used as basecourse was slag RBU100, conforming to NSW RTA Specification 3051. Other nearby applications where WEM has used the same material include Henderson Rd Ingleburn and Remembrance Drive South Camden. The product achieves a compacted density of 2.00t/m³ in just 6 passes of a standard roller, providing both technical and commercial advantage to the projects.



Slag stabilisation

PRODUCTS FOR THE CRAIGIEBURN BYPASS

The 17 km \$306 million Craigieburn Bypass fully funded by the Federal Government and being delivered by the Victorian State Government will link the Hume Freeway near Mt Ridley Road at Craigieburn, to the Metropolitan Ring Road at Thomastown. Work started in May 2002 and is expected to be finished in mid-2005.

Two traffic lanes are being constructed in each direction along the entire length with provision made for a future third lane, each way.

The selected route for the bypass delivers the best balance of transport efficiencies and economic benefits, while minimising the impact on the environment and the community. A Project Environmental Protection Strategy (PEPS) provides for appropriate protection of the environment during both the construction and operational phases.

It is expected to deliver more than \$1 billion worth of economic benefits to Victoria as a result of lower travel times, fewer accidents, fuel savings and lower vehicle-operating costs for private motorists and for freight industries.

Australian construction company, Abigroup Contractors Limited, has been awarded all four design and construct contract packages with approximately 25% per cent completed to date (12 November 2003).

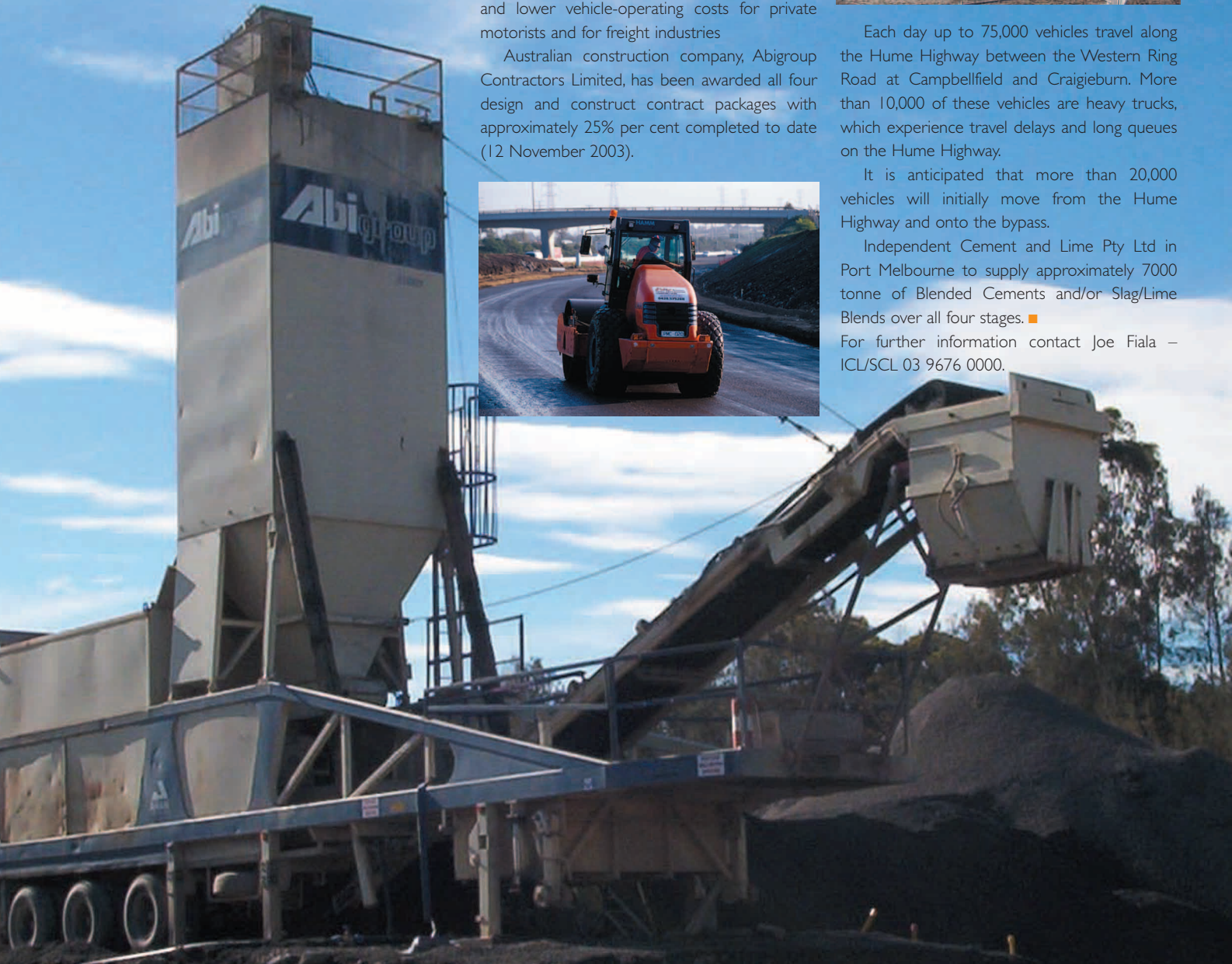


Each day up to 75,000 vehicles travel along the Hume Highway between the Western Ring Road at Campbellfield and Craigieburn. More than 10,000 of these vehicles are heavy trucks, which experience travel delays and long queues on the Hume Highway.

It is anticipated that more than 20,000 vehicles will initially move from the Hume Highway and onto the bypass.

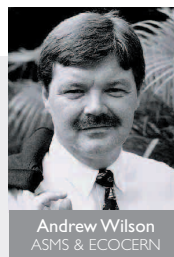
Independent Cement and Lime Pty Ltd in Port Melbourne to supply approximately 7000 tonne of Blended Cements and/or Slag/Lime Blends over all four stages. ■

For further information contact Joe Fiala – ICL/SCL 03 9676 0000.



Member Profiles

Andrew Wilson (ASMS & Ecocem) Andrew Wilson joined ASMS and Ecocem in March 2003 as C.E.O., replacing Peter Taylor who left in late 2002. Andrew came to ASMS after a long history with the BOC gas group, working both in Australia and in Asia. He has both financial as well as operational experience and brings to the company a focus on safety and quality. Andrew's formal qualifications are; B Com. and MBA from Melbourne University. He is currently settling his family in the Illawarra region as he settles into his new position. As the C.E.O of Ecocem Pty Ltd he represents the company as a member of the Australasian Slag Association (ASA).



Joe Fiala (ICL/Steel Cement) Joe Fiala is a new member of the Education and Promotion Committee. His position as Engineer – Pavements has responsibility to increase the awareness, promote, market and product develop current and new blended cements in particular slag blends. He also holds current position as a Director on AustStab Executive Council and sits on the Victorian Promotions Group for Stabilisation. Educated in Engineering (Civil) he previously worked for Austrak Pty Ltd (Barclay Mowlem) Manufacturers of Concrete Railway Sleepers and as Production Engineer and Operations Engineer from Independent Cement and Lime Pty Ltd / Steel Cement Ltd. Prior to his current ICL/SCL appointment In this role he had day to day operations and maintenance of cement bagging, slag blending and milling facility and was involved in the Project Management in building the of Maldon (NSW) Blending Facility and the various ICL / SCL upgrades over the years.

Taking the Slag Story on the Road

In today's world, the emphasis is clearly of resource and energy conservation within achievable budgets. Over the past decade, the Australasian Slag Association has been showing ways in which the use of iron and steel slag products can significantly address these issues.

Projects such as the Sydney Harbour Tunnel, Opera House sea wall, Sydney's 3rd runway pavement, Melbourne Entertainment Centre, Bolte Bridge, Melbourne Aquatic Centre and others demonstrate acceptance and product reliability. In these applications, the materials have been chosen for their ability to contribute to the long-term durability of structures, resource and energy conservation.

The Association's new tailored presentation is able to show how your durability, resource and energy conservation needs can be met using iron and steel slag products. Presentation topic areas include:

- Slag in Concrete Construction & Pavement Technologies
- Slag in concrete construction applications – case studies
- Environmental benefits derived from increased utilisation
- Slag in road pavement, base and sub base construction

We would be delighted to present an appropriate selection of this material to you and your colleagues at a time of mutual convenience at your offices. Response to date has been encouraging, don't delay, and fax the form below today to book your presentation. ■

Australasian Slag Association: Technical Seminars

I am interested in: (please tick ✓) **PHOTOCOPY AND EXPRESS FAX TO: 4228 1777**

☐ Receiving a presentation on ☐ Receiving more information about

Presentation topic areas: (please tick ✓)

- ☐ Slag in Concrete Construction and Pavement Technologies
- ☐ Slag in concrete construction applications – case studies
- ☐ Environmental benefits derived from increased utilisation
- ☐ Slag in road pavement, base and sub base construction
- ☐ Other (please specify)

Contact Name	Position
Organisation	
Business Category	
Postal Address	P/Code
Street Address (if different)	
Telephone	Mobile Phone
Facsimile	Email
Expected number of people	Preferred times/dates
Potential disciplines attending	

Company Members

A primary role of our Association 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 information on the Association and how you can become involved, just complete the information section at the end of this newsletter.

Current membership is as listed below.

Australian Steel Mill Services Pty Ltd
BlueScope Steel Ltd (Port Kembla)
Blue Circle Southern Cement Ltd
Brambles Equipment Ltd
Brambles Industrial Services Ltd (Whyalla)
Concrete Pty Ltd
CSIRO CMIT
Gough & Gilmour Pty Ltd
Heckett Multiserv (UK)
Hunter Mill Services Pty Ltd
Komatsu Australia Ltd
Mahaffey Associates Pty Ltd
Metserv Australasia Pty Ltd
Milburn New Zealand Ltd
OneSteel Limited (Whyalla)
University of Newcastle – Mr Stephen Fityus
University of Wollongong – Dr Denis Montgomery
Premium Tyre Service Pty Ltd
Readymix Holdings Pty Ltd
Roads & Traffic Authority of NSW
Slag Cement Sdn Bhd, Malaysia
Smorgon Steel Ltd (Melbourne)
Smorgon Steel Ltd (Newcastle)
Steel Cement Ltd
SteelServ Ltd (NZ)
Steelstone Services (Aust) Pty Ltd
Sunstate Cement Ltd
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Related Associations

National Slag Association (US)
Nippon Slag Association (Japan)
European Slag Association (EU)

Ensuring that Universities and their Engineering and Architecture students and lecturers have an appreciation of slag products remains a key focus of the Association. During the quarter presentations were made to:

June – South Australian EPA (SAEPA)
– Australian National University
– Australian Defence Force Academy.

August – National Environment Protection Council (NEPC) – Wollongong City Council – Brisbane City Council.

June/October – Concrete Institute of Australia.

PRESENTATIONS



NEWS BRIEFS



Shareholder Changes at Ecocern

In June 2003 Ecocem Pty Ltd changed its shareholding, although not its operating practises. From its inception in January 2001 Ecocem has operated as a joint venture between the E C Levy (Aus) Pty Ltd and Holcim Ltd, similar to its sister company ASMS Pty Ltd.

With the merger of Holcim's Australian operations with those of Australian Cement Holdings Pty Ltd on the 2nd June 2003, to form cement Australia Pty Ltd, Ecocem also underwent shareholder changes, with Holcim's 50% ownership of the company transferring to Cement Australia.

However on a day-to-day basis, nothing has changed or is likely to in the future. Ecocem remains the only producer of ground slag as a cementitious binder in the NSW market, competing with both Portland and blended cements and Flyash. And with a new focus, courtesy of the Cement Australia ownership, its future looks even brighter.



Ecocern Plant

Personnel change at SCE Group

Ross Carter left his position as SCE Group General Manager - Northern NSW on Thursday 23rd October 2003. Ross will be missed by all in the group, and our best wishes go with him for the future.

Rob Bell former Operations Manager - Penrith Lakes Development Corporation, will take up his appointment with the SCE Group as SCE Group General Manager - Northern NSW on 10th November 2003.

USA: Residential Design Symposium in Denver

The National Concrete Masonry Association and Portland Cement Association and four regional promotion groups teamed up to organize the 2003 Residential Design Symposium in Denver. The event was aimed to educate design professionals, builders, community leaders and contractors on the benefits of designing and building with concrete, concrete block and Brick products. The Slag Cement Association recently honoured individuals for their service to the industry. Presenting the awards at the association's annual meeting in New Orleans earlier this year, SCA President Randy Dunlap of Holcim (US) Inc. noted that the tremendous growth of U.S. slag shipments of 22% in 2002 alone is attributable in large part to the educational and promotional efforts of SCA volunteers.

Source: Concrete Products.

USA: Slag cement use triples since 1996

At its second Annual meeting in New Orleans, LA (6-8 May 2003) the Slag Cement Association reported a 24% increase in slag cement sales for the previous 12 months and a tripling in volume since 1996. They attribute this to:

- "Slag is now more widely available east of the Rockies
- Specifiers, producers and contractors are recognizing the merits of slag cements - consistency, strength, durability, value
- Environmental benefits from reuse and from "green" projects".

Source: (USA) National Slag Association newsletter "Slagrunner".

Slag - "the ultimate renewable mineral resource"

The video has proved to be very useful to many members. 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.



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.

Technical Resources on CD

ASA produces a number of high quality technical guides (i.e. the new - "A Guide to the use of Iron and Steel Slag in Roads" and the "Guide to the Use of Steel Furnace Slag in Asphalt and Thin Bituminous Surfacing") bulletins, newsletters and general industry information on current issues. The Education and Promotion Committee has developed a Technical Compendium on CD; an invaluable readily accessible reference tool for engineers, specifiers, consultants, government authorities, and slag users. A limited number of hard copies are also available.



Copies are available to members at a cost of \$15.00 each, non members \$20.00 — plus postage and handling. Updated CD's will be available for registered users as new material is added. Stay up to date! Complete and fax back the subscription/order form today.

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