DINCEL STRUCTURAL WALLING

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FLY ASH CEMENT CONCRETE

The following document is recommended to be read in conjunction with (Download – Dincel Solution for Concrete Problems and Cement Minimisation)

STATEMENTS:

- **The compliant (i.e. treated) fly ash use for conventional concrete mix is defined by American ASTM 618 and Australian AS3582.1. The following document explains why compliant fly ash use is not necessary when concrete mix of up to 50% fly ash is encapsulated by waterproof DINCEL FORMS.**
- **Fly ash with Dincel Construction System can be used up to at least 50% cement replacement in concrete making. Refer reference No: (5) considering permanent waterproof Dincel polymer forms eliminate durability concerns for concrete.**
  Untreated fly ash concrete will be more susceptible to environmental degradation/concrete cancer without the permanent waterproof polymer protection of Dincel-Wall.
- **Additional cement use to decrease the porosity of concrete is not warranted when Dincel Construction System is used. This is because concrete with less cement is protected by the waterproof polymer of Dincel. Refer (Refer "Basement Construction Dincel Wall").**

FOREWORD

The main environmental challenge for the cement industry worldwide is to control and minimise CO_2 emissions associated with cement production. Other heavy industries seek different ways of efficiently managing their manufacturing processes and even utilise their own waste. Fly ash which is a residue of coal fired power plants is usually considered to be a waste product since its high content in carbon with non-uniform particles cannot be used as a suitable material in the structural concrete making, nor can its carbon content be a useful and cost-effective additive or replacement of cement.

The Australian coal-fired power generation industry produces 9 million tonnes per annum of fly ash. Less than 10% of this fly ash is used, with most of it being considered as waste.

The issues are:

- This waste must be disposed of in an environmentally acceptable way at a cost which is increasing as legislated requirements become more demanding.
- If fly ash is used extensively in the construction industry, then fly ash waste disposal costs will be significantly reduced whilst achieving reduction in greenhouse emissions.

Dincel Construction System as tested and certified by the CSIRO (Download - CSIRO Report NO: 5091) is a waterproof system, i.e. offers durability protection to its concrete infill. Therefore, fly ash of up to 50% (even with exceeding conventionally maximum allowable 6% unburned carbon content) can be used as a replacement for Portland cement.

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TECHNICAL REASONS WHY UNTREATED FLY ASH IS NOT USED IN CONCRETE MAKING

Coal is the product of millions of years of decomposing vegetable matter under pressure, and its chemical composition is erratic. Fly ash is a residue left from burning coal. 78% of Australian electric power production is from coal burning and plants use a number of additives to optimise power production. The resulting fly ash can have a variable composition and uniformity and contains several additives as well as products from incomplete combustion resulting in high carbon fly ash content.

Properly cured concrete (i.e. permanent polymer encapsulation by Dincel) made with fly ash creates a denser product because the size of the pores are reduced due to the ongoing hydration process. This increases the strength and reduces the permeability of concrete within Dincel-Wall.

The benefits of fly ash in concrete making includes improvements in workability, bleeding, pumpability, cohesiveness, ultimate strength and replacement of cement, hence a reduction in concrete cost. However, despite these benefits, only less than 10% of 9 million tonnes per annum of Australian fly ash production is used in concrete making, mainly mass concrete and road base purposes. The use of fly ash in the making of structural concrete is currently extremely low. The reasons for this are the disadvantages associated with fly ash in structural concrete making. These are:

- If untreated fly ash concrete is made with poor quality and/or high quantity fly ash, inadequately proportioned and cured, it becomes highly permeable, particularly in the early ages. Under such conditions, chlorides as well as moisture and oxygen penetrate the concrete and the protective layer at the reinforcing steel surface can be destroyed.

  As the steel corrodes, it expands and develops stresses which eventually induce cracking, delamination and spalling of the concrete.

  The quality of fly ash is determined by its carbon level, type of carbon, variability of carbon content and fineness (coarse fly ash may contain a higher carbon content).
- Freeze-thaw durability may not be acceptable with the use of fly ash in concrete. The amount of air entrainment in the concrete controls the freeze-thaw durability, and the high carbon content in certain fly ash products absorbs some air entraining agents, thus making it very difficult to control the consistency of entrained air. The end result is an inadequate air-void system in the concrete. This results in concrete that is less resistant to cyclic freeze-thaw damage and exhibits lower workability and reduced durability. This problem also limits the use of untreated fly ash in climates that are subject to freeze-thaw conditions.
- The effects of fly ash on alkali-aggregate reactions in concrete.
- Slow set and low early strength due to the high alumina and iron oxide content.

It is clear that if durability is not a problem, irrespective of its carbon level or fineness, fly ash can be used in Dincel-Wall. **As tested and certified by the CSIRO-Australia, Dincel-Wall is an impermeable permanent polymer formwork offering significantly improved concrete curing and is the solution to the abovementioned durability problems.** This way, the majority of the 9 million tonnes per annum of Australian fly ash can be used in structural concrete making with the availability of Dincel without causing difficulties or additional costs for treating fly ash.

COMMERCIAL REASONS WHY UNTREATED FLY ASH IS NOT USED IN CONCRETE MAKING

Conventional concrete mix incorporating fly ash is required to consider the following issues:

The two properties of fly ash that are of most concern in the concrete mix design are the carbon content and the fineness. Both of these properties will affect the air content and water demand of the concrete.

- The finer the material the higher the water demand due to the increase in surface area. The finer material requires more air-entraining agent to fire the mix to the desired air content. The important thing to remember is uniformity. If fly ash is uniform in size, the mix design can be adjusted to give a good uniform mix.
- The carbon content, which is indicated by the loss of ignition, also affects the air entraining agents and reduces the entrained air for a given amount of air-entraining agent. An additional amount of air-entraining agent will need to be added to get the desired air content. The carbon content will also affect water demand since the carbon will absorb water. Again uniformity is important since the differences from non-fly ash concrete can be adjusted in the mix design.

Concrete producers (majority of them are Portland cement producers as well) do not allow the use of fly ash as a replacement for cement in structural concrete making. The reasons for this may be a combination of the following:

(i) Fly ash is required to have low carbon content or coated to avoid high carbon effects. It also needs to be a fine and uniformly graded material. These are the processes that increase the cost of untreated fly ash use as a cement replacement.

(ii) The use of fly ash in its raw form represents technical problems in concrete making and its performance. If raw fly ash is to be treated, the significant cost of the process is enough to stop using fly ash as a replacement for cement.

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The availability of Dincel achieves:

- Elimination of the need for the additional treatment cost of fly ash as a cement replacement.
- Elimination of the significant cost of untreated fly ash disposal as land fill by coal burning power plants which produce fly ash.
- Reduced CO_2 emissions by replacing the use of Portland cement.
- Reduced use of concrete additives and cement content by up to 50% which result in cheaper concrete.
- Allows the use of coarse aggregates such as corals, shale, coal, bottom ash, waste material from mining processing, etc. to be used in concrete making.

The following will assist concrete manufacturers to incorporate up to 50% of fly ash use:

- Building Regulations and Concrete Standards recognising that fly ash is a significant CO_2 reducer and the Building Authorities providing environmental credits (similar to the Australian Green Star rating) that affects the marketability of the end product.
- Up to 50% of fly ash usage represents **DINCEL'S CHEAPER CONCRETE SUPPLY**.

WARNING – USE FLY ASH CONCRETE ONLY WITH DINCEL-WALLS

Fly ash concrete is only recommended to be used with Dincel-Wall. The reasons for this are:

- Concrete utilising significant amounts of fly ash (treated or untreated) will be more porous than conventional concrete without fly ash. Therefore, fly ash concrete will be more susceptible to environmental degradation including concrete cancer.
- Dincel's impervious and waterproof polymer formwork protects the porous concrete infill against durability problems.
- The presence of the impervious permanent Dincel polymer formwork ensures that the concrete hydration period extends for a long period of time. The ongoing hydration achieves less porosity and denser concrete with higher capacity as experienced with the following test report by Holcim.

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SAMPLE FLY ASH CONCRETE MIX

Dincel project consisting of 223 apartments in Canberra, Australia.

Holcim

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Concrete Test Report

Report No: WFYS11/02722
Issue No: 6
This report replaces all previous issues of report no 'WFYS11/02722'.

Client:	MILIN BROS BUILDERS PTY LTD PO BOX 4362 KINGSTON ACT 2604
Project:	ECLIPSE - BRUCE ECLIPSE
Supplier:	HOLCIM (AUSTRALIA) PTY LTD

Accredited for compliance with ISO/IEC 17025.

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

Approved Signatory: Merv Uren
NATA Accredited Laboratory Number: 327-455
Date of Issue: 16/03/2012
THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

COMPRESSIVE STRENGTH OF CONCRETE CYLINDERS

Details of Sampled Concrete / Concrete Specimens and Results

Date & Time Batched Load / Prog. Load	Truck No Time Sampled	Plant Name Docket No Product Code	Grade(MPa) Agg(mm) Slump(mm) Design	Air (%) Compact Slump(mm) Measured	Specimen Ident.	Dimensions (mm) Avg. Diameter	Height	Density (kg/m³)	Curing Initial (hrs)	Std (days)	Type of Cap	Date of Test	Age (days)	Strength (MPa)	Marks	Fail Mode	Location & Remarks
17/11/11	2560	MITCHELL	S20		27661A	99.6	194	2240	22	3	G	21/11/11	4	5.8		N	Sampling AS 1012.1 Cl 6B
10:20	11:04	45180621	20	Ex/Vibe	27661B	99.6	195	2240		6	G	24/11/11	7	8.0		N	Wall 1 to 2
6/22.8		NS20TBMXD	120	120	27661C	99.8	196	2240		27	G	15/12/11	28	19.5		N	Concrete Temp. (°C): 27
					27661D	100.0	195	2240		27	G	15/12/11	28	18.0		N	
					27661E	100.2	195	2240		55	G	12/01/12	56	26.0		N	
					27661F	99.8	194	2240		55	G	12/01/12	56	26.0		N	
					27661G	99.8	194	2280		90		16/02/12	91	30.0		N	
					27661H	99.8	195	2260		13		01/12/11	14	14.0		N	
					27661I	99.6	194	2280		119		16/03/12	120	32.0		N	

Notes

1. Sampling in accordance with AS 1012.1
2. Slump Test in accordance with AS 1012.3.1
3. Compaction by vibration, in accordance with AS 1012.8.1 Clause 7.4
4. Initial Curing in accordance with AS 1012.8.1 Clause 9.2.2
5. Standard Curing in accordance with AS 1012.8.1 Clause 9.3(a)
6. Type of Cap: R-Rubber, S-Sulphur, G-End Ground, 3-Double Sulphur, 9-No Cap
7. Compressive Strength in accordance with AS 1012.9
8. Density in accordance with AS 1012.12.1
9. Moisture Condition SSD in accordance with AS 1012.12.1, unless otherwise stated

Remarks

FailureMode: N = Normal
Compaction: Ex/Vibe = External Vibration

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THE WINNER IS THE ENVIRONMENT

From 2008 to 2009 the Australian Bureau of Statistics shows that 23 985 000 m3 / year of concrete has been used in Australia. This quantity of concrete would fully utilise the entire 9 million tonnes of Australian fly ash when used as cement and an aggregate replacement for concrete making if the durability of concrete made with fly ash was not a problem. Dincel-Wall is the only solution to offer this opportunity to the concrete industry.

Coal processing for power generation is the main source of fly ash and CO_2 generation. Cement production also generates CO_2. The 50% cement replacement with fly ash offers a considerable CO_2 reduction and provides a resource for concrete making with the presence of Dincel, particularly in countries like Australia, India and China where the majority of power generation comes from coal burning.

The biggest winner out of the above will be the environment. With the world's population growing, the concrete industry can assist to absorb significant use of fly ash which is normally waste material for landfill. This way, the large waste management issue created by the coal burning power plants and the significant CO_2 production will be eliminated.

REFERENCES

(1) Javed I Bhatty, John Gajda and F M Miller Commercial Demonstration of High-Carbon Fly Ash Technology in Cement Manufacturing, Construction Technology Laboratories, Inc, Illinois

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(3) Alek Samarin, Total Fly Ash Management: from Concept to Commercial Realty, The Australian Coal Review, November 1997.

(4) US Department of Transportation, Federal Highway Administration, Infrastructure Materials Group – Fly Ash (www.fhwa.dot.gov/infrastructure/materialsgrp/flyash.htm)

(5) Green in Practice 107 – Supplementary Cementitious Materials, Portland Cement Association (http://www.concretethinker.com/technicalbrief/Supplementary-Cementitious-Materials.aspx)

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