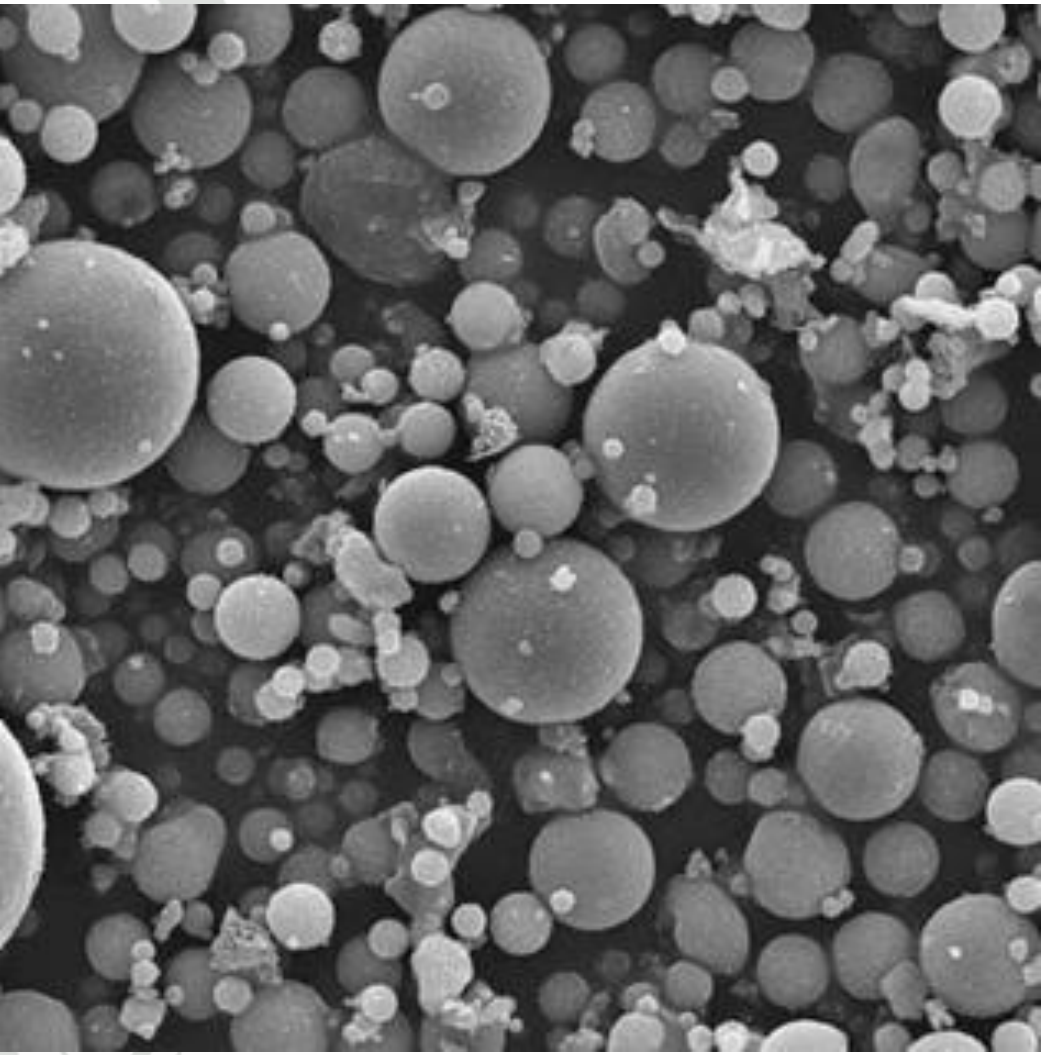
INTRODUCING FLY ASH INTO READY MIXED CONCRETE

READYMIX

CONTENTS

What Is ‘Fly Ash’?



Fly ash is a by-product of burning pulverized coal in an electrical generating station. Specifically, it is the unburned residue that is carried away from the burning zone in the boiler by the flue gases and then collected by either mechanical or electrostatic precipitators.

What Is ‘Fly Ash’?

Fly ash is used as a supplementary cementitious material (SCM) in the production of portland cement concrete. A supplementary cementitious material when used in conjunction with portland cement contributes to the properties of the hardened concrete through hydraulic or pozzolanic activity or both.

Physical Aspect

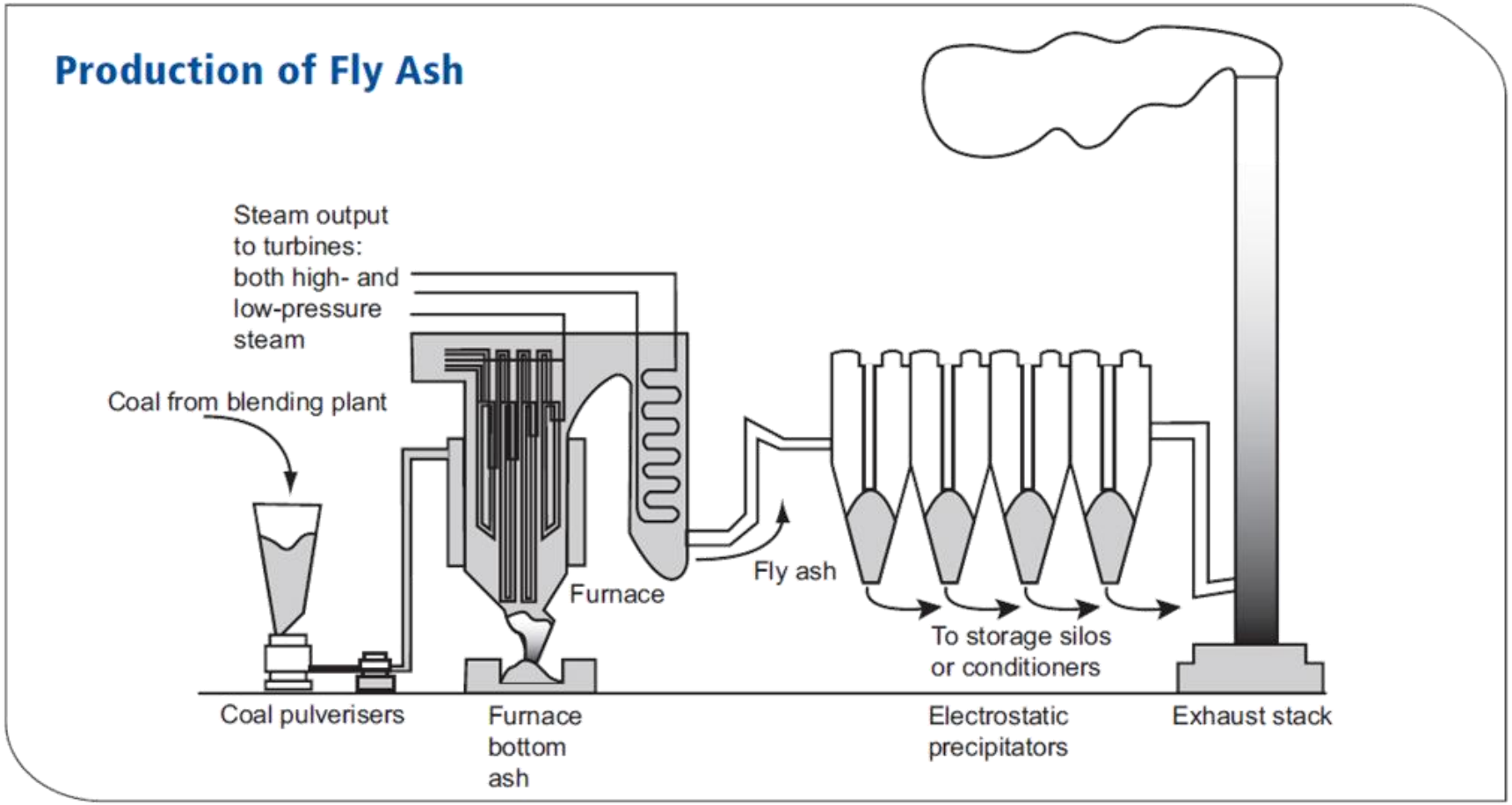
The fly ash from the boilers where mechanical collectors are used is coarser than fly ash from electrostatic precipitators

The color varies from light to dark grey depending upon its carbon contents

The quality of fly ash varies from source to source

Fly ash particles are small, they effectively fill voids

How does Fly Ash produced?



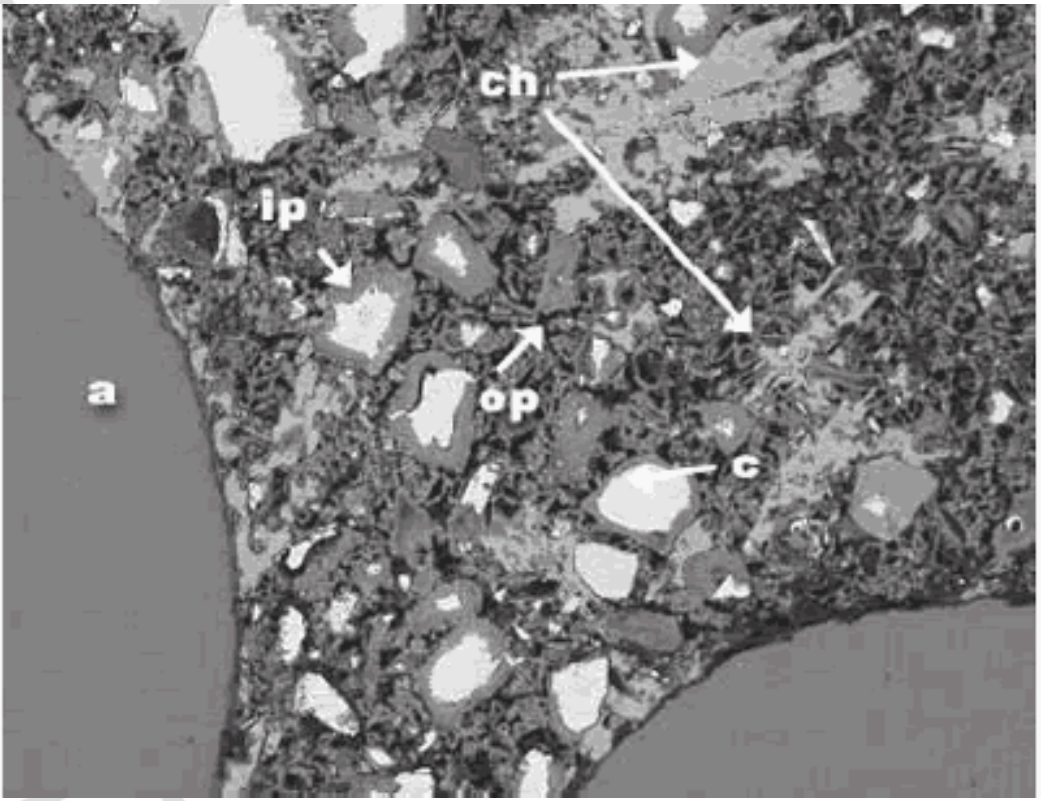
Why Fly Ash?

Fly ash has a high amount of silica and alumina in a reactive form. These reactive elements complement hydration chemistry of cement.

When cement reacts with water, we say that hydration of cement has began and produces C-S-H (Calcium-Silicate-Hydrate) Gel.

C-S-H Gel binds the aggregates together and strengthens concrete.

Why Fly Ash?



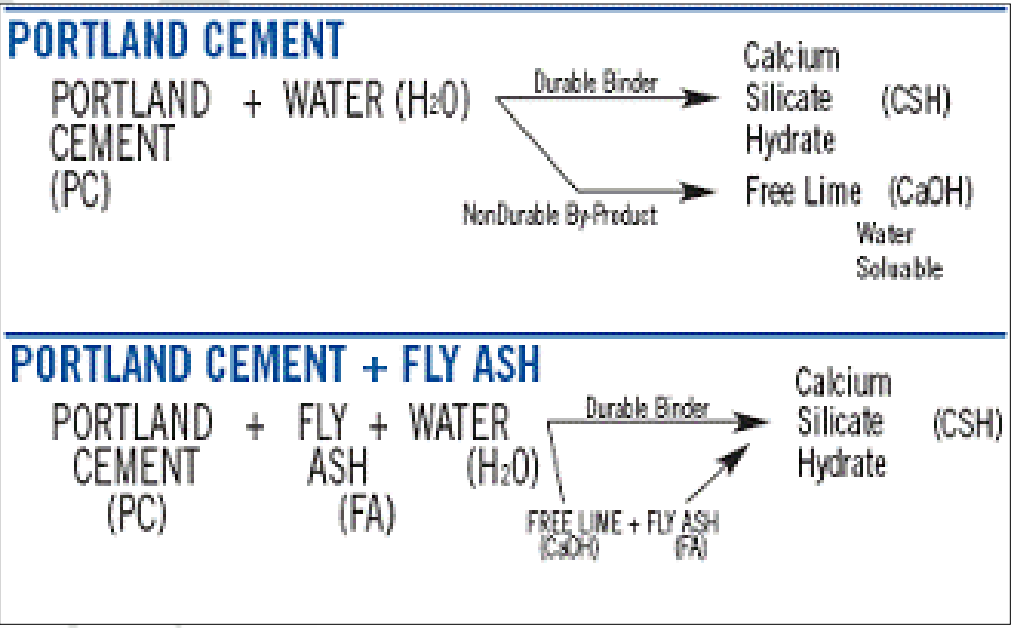
However, one more compound is produced on hydration that is so different in behaviour. It is non other than the Calcium Hydroxide Ca(OH)2.

In construction industry, it is generally referred to as **Free Lime**.

Why Fly Ash?

Aggressive environmental agents like water, sulphates, CO_2 attack this free lime leading to deterioration of the concrete.

Why Fly Ash?



Fly ash, on itself, can not react with water. It needs ***free lime***, produced on hydration of Portland cement, to trigger off its Pozzolanic effect.

Once it is triggered, it can go on and on!

Definition: A pozzolan is defined as a siliceous or siliceous and aluminous material that in itself possesses little or no cementitious value, but that will, in finely divided form and in the presence of moisture, **chemically react with calcium hydroxide** at ordinary temperatures to form compounds having cementitious properties

Why Fly Ash?

In simple words, all this means a much longer life for our concrete structure.

Concrete Performance

Specific benchmarks have been set up to evaluate the performance of concrete with respect to durability—mainly Strength and Permeability. This means to produce a durable and long lasting concrete, it must posses: -

High strength
And
Low permeability

Concrete Performance

Fly ash makes concrete denser, and hence less permeable, mainly by : -

- Reducing water demand in concrete
- Improving microstructure of concrete

At the same time, fly ash improves long term strength of concrete due to the **continued** Pozzolanic reaction as discussed earlier.

Classification of Fly Ash

- ASTM C618 defines two (2) classes of Fly Ash:
  - ✓ Class C
  - ✓ Class F
- Primary difference between Class C and Class F fly ash are the amount of calcium, silica, alumina & iron content.

Table 2. ASTM Specification for Fly Ash

Class	Description in ASTM C 618	Chemical Requirements
F	Fly ash normally produced from burning anthracite or bituminous coal that meets the applicable requirements for this class as given herein. This class of fly ash has pozzolanic properties.	$SiO_2 + Al_2O_3 + Fe_2O_3 \geq 70\%$
C	Fly ash normally produced from lignite or sub-bituminous coal that meets the applicable requirements for this class as given herein. This class of fly ash, in addition to having pozzolanic properties, also has some cementitious properties. Note: Some Class C fly ashes may contain lime contents higher than 10%.	$SiO_2 + Al_2O_3 + Fe_2O_3 \geq 50\%$

Classification of Fly Ash

Class F

- Produced from burning harder, older anthracite and bituminous coal.
- Contains less than 15% lime.
- Requires cementing agent like PC, quick lime, hydrated lime.
- Used in high sulfate exposure conditions
- Use for structural concrete, high performance concrete, high sulfate exposure concrete.
- Useful in high fly ash content concrete mixes.

Classification of Fly Ash

Class C

- Produced from burning lignite and sub-bituminous coal.
- Higher concentration of alkali and sulfate.
- Contains more than 15% lime.
- Self-cementing properties.
- Not to be used in high sulfate conditions.
- Primarily residential construction.
- Limited to low fly ash content concrete mixes.

Comparison between different classes of Fly Ash & OPC

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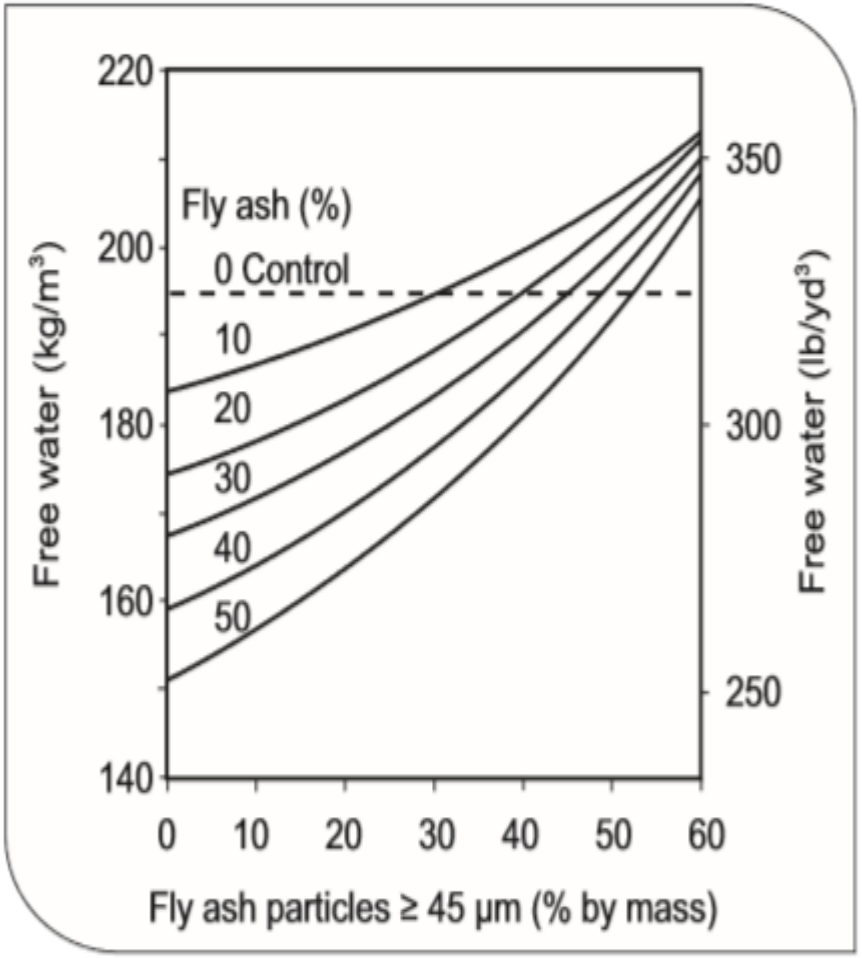
CHEMICAL COMPOUND	POZZOLAN TYPE			CEMENT
	CLASS F	CLASS C	CLASS N	
SiO	54.90	39.90	58.20	22.60
Al_2O_3	25.80	16.70	18.40	4.30
Fe_2O_3	6.90	5.80	9.30	2.40
CaO	8.70	24.30	3.30	64.40
MgO	1.80	4.60	3.90	2.10
SO_3	0.60	3.30	1.10	2.30
Na_2O & K_2O	0.60	1.30	1.10	0.60

Effects of Fly Ash in Fresh Concrete



Workability

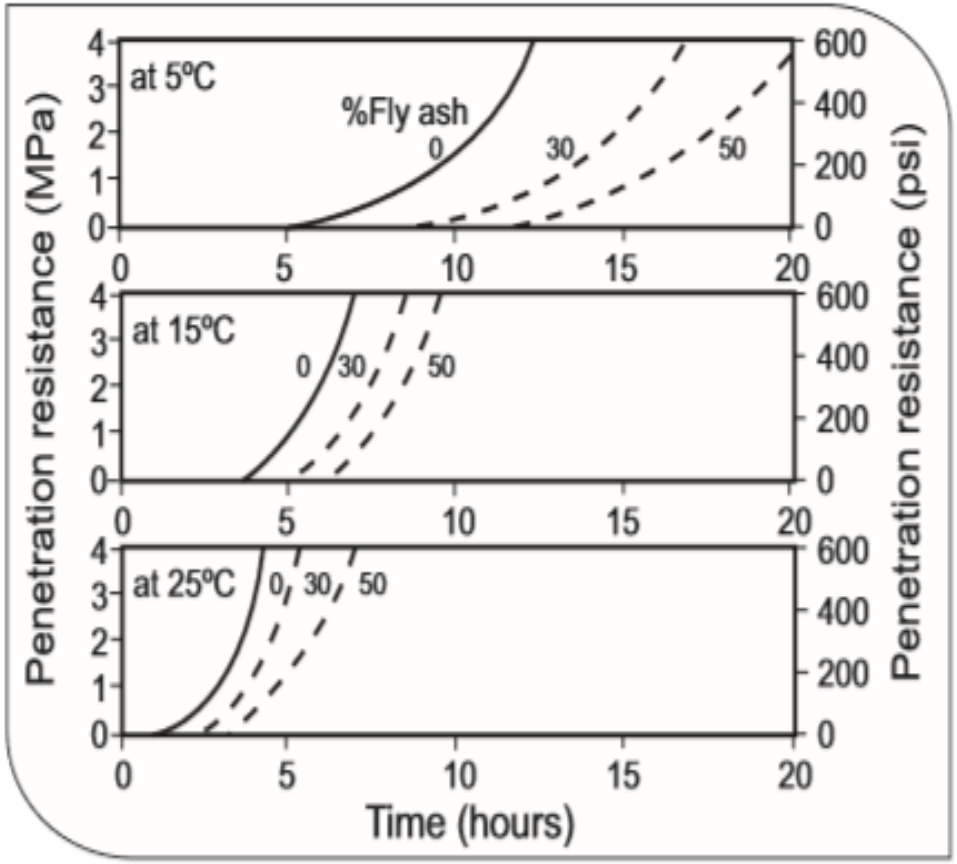
The use of good quality fly ash with high fineness and low carbon content reduces the water demand of concrete and consequently, the use of fly ash should permit the concrete to be produced at a lower water content when compared to a portland cement concrete of the same workability.

Effects of Fly Ash in Fresh Concrete

Bleeding

Generally fly ash will reduce the rate and amount of bleeding primarily due to the reduced water demand.

Effects of Fly Ash in Fresh Concrete



Setting Time

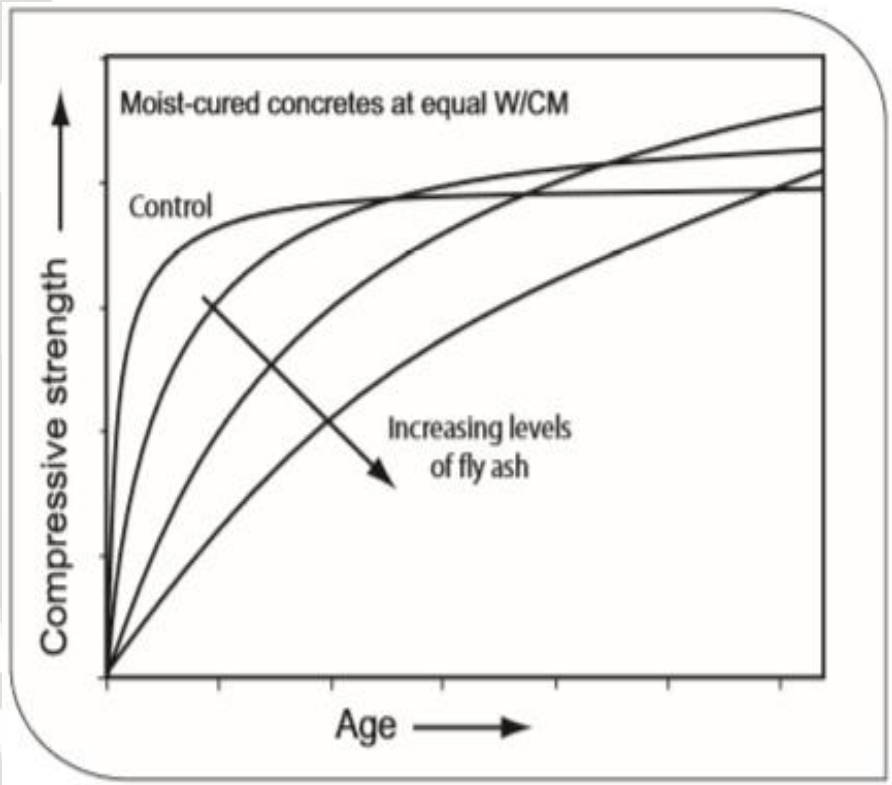
The impact of fly ash on the setting behaviour of concrete is dependent not only on the composition and quantity of fly ash used, but also on the type and amount of cement, the water-to-cementitious materials ratio (w/cm), the type and amount of chemical admixtures, and the concrete temperature. However, it is fairly well-established that low-calcium fly ashes extend both the initial and final set of concrete.

Effects of Fly Ash in Fresh Concrete

Heat of Hydration

The reduction in the rate of the heat produced and the internal temperature rise of the concrete has long been an incentive for using fly ash in mass concrete construction.

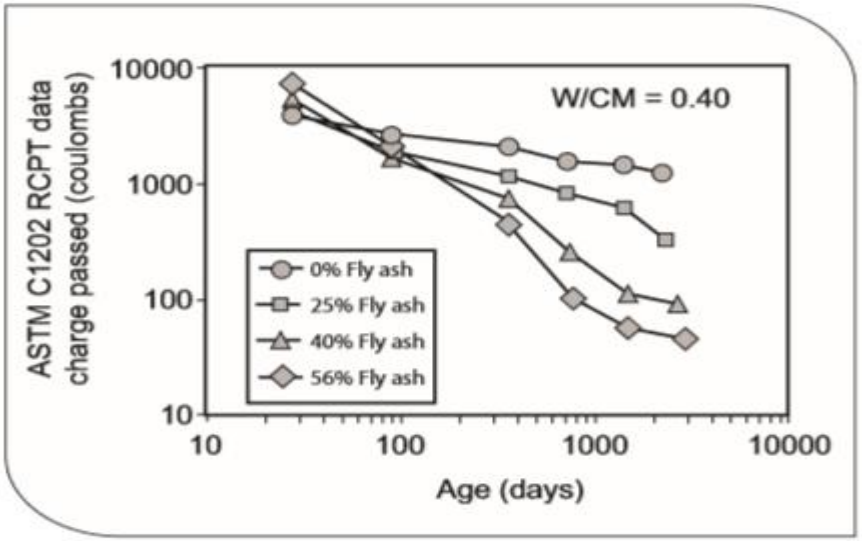
Effects of Fly Ash in Hardened Concrete



Strength Development

By replacing a certain amount of portland cement with the same amount of fly ash and maintaining a constant w/c. As the level of replacement increases the early-age strength decreases. However, long-term strength development is improved when fly ash is used as against portland cement concrete.

Durability of Concrete



Resistance to the Penetration of Chlorides

Fly ash reduces the permeability of concrete to water and gas provided the concrete is adequately cured *(Thomas 2002)*.

This has been attributed to a refinement in the pore structure.

Durability of Concrete

Sulphate Resistance

Studies have demonstrated that the use of sufficient quantities of low-calcium Class F fly ash can increase the resistance of concrete to chemical attack when the concrete is exposed to sulphate-bearing soils or groundwater.

Durability of Concrete

Alkali-Silica Reaction

It is well established that low-calcium (Class F) fly ash is capable of controlling damaging alkali-silica reaction (ASR) in concrete at moderate levels of replacement (20% to 30%) and the effect has been ascribed to the reduced concentration of alkali hydroxides in the pore solution when fly ash is present.

Importance of Curing

Important for development of strength & durability properties

Prevention of moisture loss is important : (a) when W/C ratio is low (b) when cement has a high rate of strength development & (c) when concrete contains mineral admixtures

Moisture loss from concrete surface specially for thin elements, relatively high in hot & dry climate

Fly Ash Is GREEN, Not Gray

Quote by:

Nicholas Edward,
Ready Mix USA,

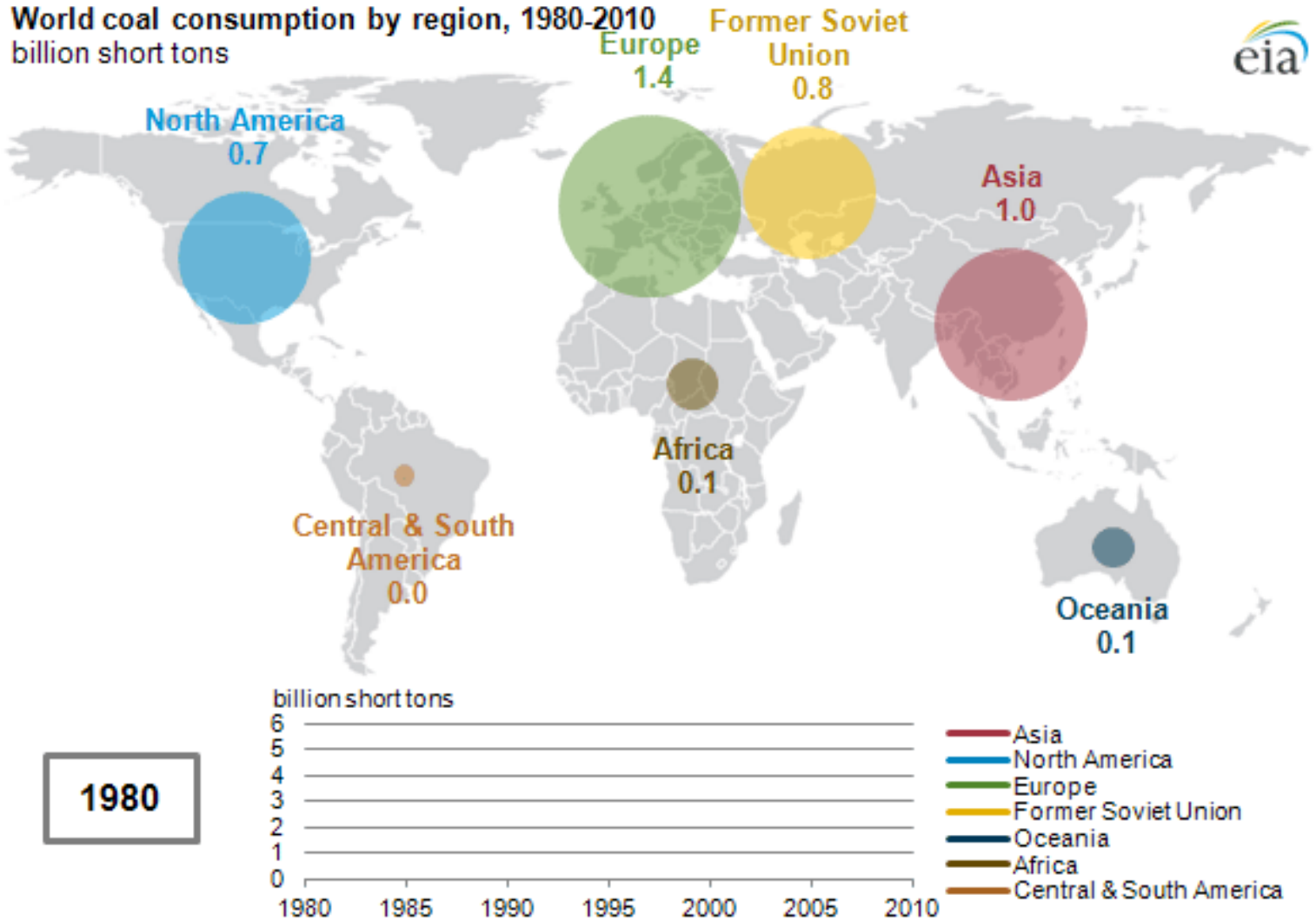
19 February 2010

Green Energy

Growth of cement usage leads to greater production of **CO_2** which is one of the major cause of global warming

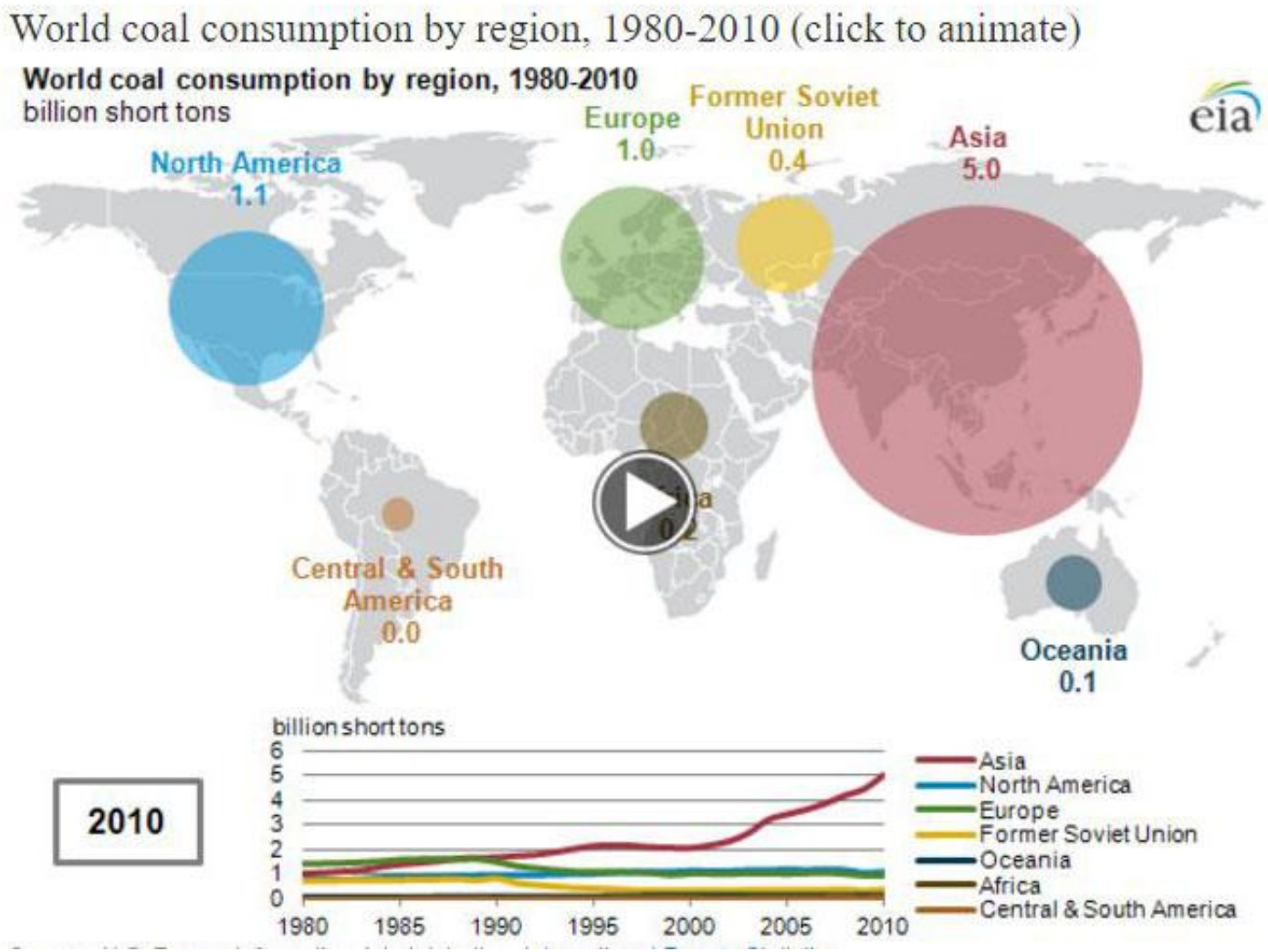
Cement industry contributes 5% of total anthropogenic **CO_2** emission globally

Global Coal Consumption



http://www.eia.gov/

Global Coal Consumption



http://www.eia.gov/

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Approved Fly Ash Importer

Tuan,

PER : PERMOHONAN BAGI KEBENARAN MEMASUKKAN 'FLY ASH'

Dengan hormatnya sukacita merujuk permohonan Tuan yang bertarikh 19hb Ogos, 2014 mengenai dengan perkara yang tersebut diatas.

Sehubungan dengan ini, sukacita dimaklumkan bahawa Jabatan ini tidak ada halangan bagi Syarikat Tuan untuk memasukkan "Fly Ash" bagi tujuan dalam proses pembuatan konkrit.

Sekian disampaikan untuk perhatian dan apa jua tindakan dari pihak Tuan selanjutnya.

"HIDUP BERDIKARI, KEHIDUPAN TERJAMIN"

BINA

بادن كماجوان ايندوستري بروني

Badan Kemajuan Industri Brunei
Brunei Industrial Development Authority
Km. 8, Jalan Gadong, BE3119
Kementerian Perindustrian dan Sumber-Sumber Utama
NEGARA BRUNEI DARUSSALAM

BINA/PDN/KASTAM

04 Zulhijjah 1435
29hb September, 2014

Yang Mulia
Ahmad Zaki bin Abdul Rahman
Pengurus Pencari Bahan Mentah
Readymix Concrete (B) Sdn Bhd
No 3B, First Floor, Bangunan Sri Nor,
Spg 158, Jln Pg Babu Raja, Kg. Kiarong BE 1318
Negara Brunei Darussalam

Tuan,

PER : PERMOHONAN BAGI KEBENARAN MEMASUKKAN 'FLY ASH'

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"HIDUP BERDIKARI, KEHIDUPAN TERJAMIN"

Dengan hormat,

(DY HAJAH MASNI BINTI HAJI MOHSIN)
b/p Pengarah,
Badan Kemajuan Industri Brunei (BINA)
Kementerian Perindustrian dan Sumber-Sumber Utama
Negara Brunei Darussalam

S.K Jabatan Kastam dan Eksais Diraja

READYMIX EXPERIENCE

Visits to suppliers to conduct quality check

READYMIX EXPERIENCE

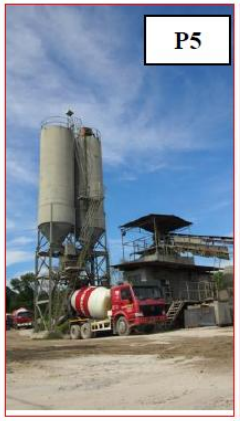
Arrived in bulk bags

Stored at warehouse

Loaded into Readymix tanker

Pumped into silo

READYMIX EXPERIENCE



Plants	Batching Capacity	Batching Software
P4 – Anduki Plant	60 m^3/hour	MHW Industrial Automation
P7 – Telisai Plant	60 m^3/hour	MHW Industrial Automation
P5 – Hj. Halus Plant	60 m^3/hour	MHW Industrial Automation
P23 – Sg. Akar Plant	75 m^3/hour	MHW Industrial Automation
P26 – Lugu On-Site Plant	60 m^3/hour	MHW Industrial Automation

READYMIX EXPERIENCE

Client: Indramas Sdn Bhd

Project: UBD Sport Complex Phase 2

Quantities: 470 m^3

Date: 21 April 2105

Start: 4:45pm, 21 April 2015

End: 00:45am, 22 April 2015

READYMIX EXPERIENCE

All ready with RCB Team at site by 4:30 pm

READYMIX EXPERIENCE

First discharge: 4:45pm

READYMIX EXPERIENCE

As at: 7:35pm

Quality Is Our Strength

READYMIX EXPERIENCE

As at: 11:58pm

Quality Is Our Strength

READYMIX EXPERIENCE

Continuous monitoring by RCB Technical Manager

READYMIX EXPERIENCE

https://www.youtube.com/watch?v=5ldLwFSLMgM

READYMIX EXPERIENCE

24 hours

Quality Is Our Strength

READYMIX EXPERIENCE

7 days

READYMIX EXPERIENCE

7 days

Quality Is Our Strength

READYMIX EXPERIENCE

7 days

READYMIX EXPERIENCE

Readymix PFA Workshop 7 May 2015

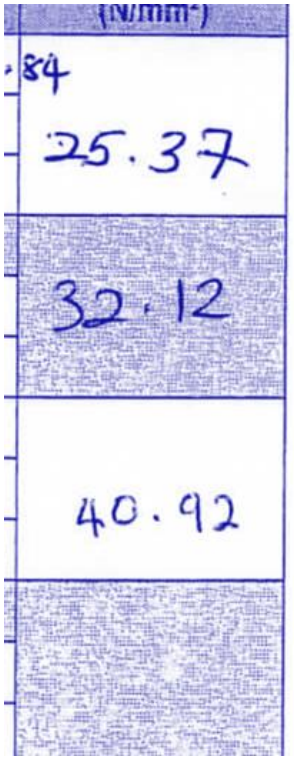
READYMIX EXPERIENCE

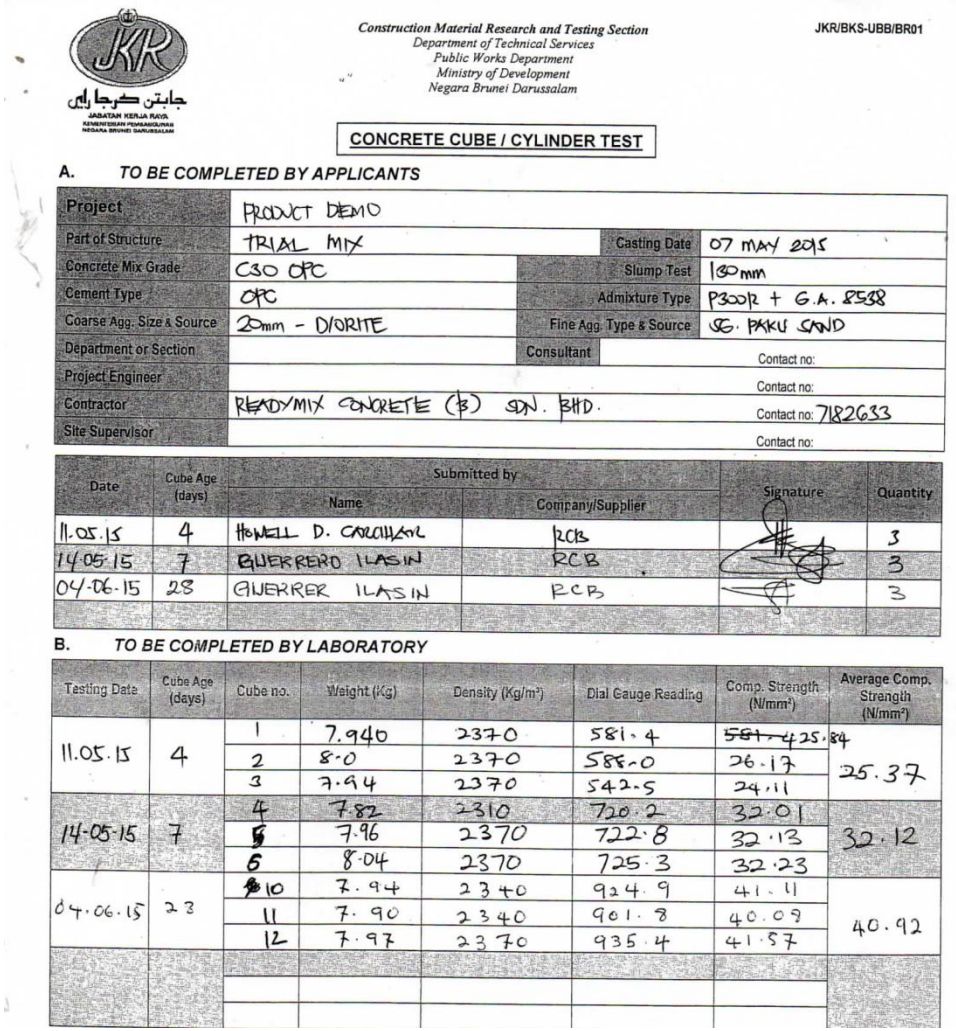
Readymix PFA Sharing with PICE 1 Nov 2015

READYMIX EXPERIENCE

Test Results (100% OPC)

Grade 30





JABATAN KERJA RAYA
KEMENTERIAN PEMBANGUNAN
NEGARA BRUNEI DARUSSALAM

Construction Material Research and Testing Section
Department of Technical Services
Public Works Department
Ministry of Development
Negara Brunei Darussalam

JKR/BKS-UBB/BR01

CONCRETE CUBE / CYLINDER TEST

A. TO BE COMPLETED BY APPLICANTS

Project	PRODUCT DEMO		
Part of Structure	TRIAL MIX	Casting Date	07 MAY 2015
Concrete Mix Grade	C30 OPC	Slump Test	180mm
Cement Type	OPC	Admixture Type	P300R + G.A. 8538
Coarse Agg. Size & Source	20mm - DIORITE	Fine Agg. Type & Source	SG. PAKU SAND
Department or Section		Consultant	Contact no:
Project Engineer			Contact no:
Contractor	READYMIX CONCRETE (B) SDN. BHD.		Contact no: 7182633
Site Supervisor			Contact no:

Date	Cube Age (days)	Submitted by		Signature	Quantity
		Name	Company/Supplier		
11.05.15	4	HOWELL D. CARCHAR	RCB		3
14.05.15	7	GUERRERO ILASIN	RCB		3
04.06.15	28	GUERRER ILASIN	RCB		3

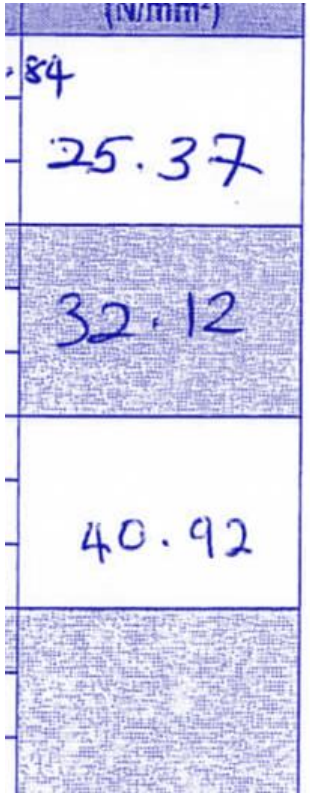
B. TO BE COMPLETED BY LABORATORY

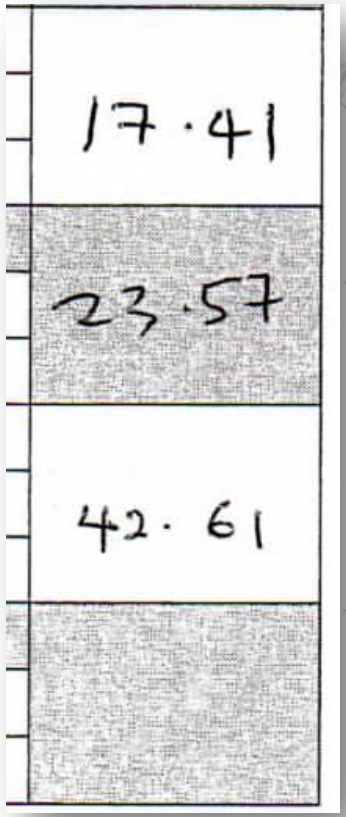
Testing Date	Cube Age (days)	Cube no.	Weight (Kg)	Density (Kg/m³)	Dial Gauge Reading	Comp. Strength (N/mm²)	Average Comp. Strength (N/mm²)
11.05.15	4	1	7.940	2370	581.4	~~581.4~~ 25.84	25.37
		2	8.0	2370	588.0	26.17	
		3	7.94	2370	542.5	24.11	
14.05.15	7	4	7.82	2310	720.2	32.01	32.12
		5	7.96	2370	722.8	32.13	
		6	8.04	2370	725.3	32.23	
04.06.15	23	10	7.94	2340	924.9	41.11	40.92
		11	7.90	2340	901.8	40.09	
		12	7.97	2370	935.4	41.57	

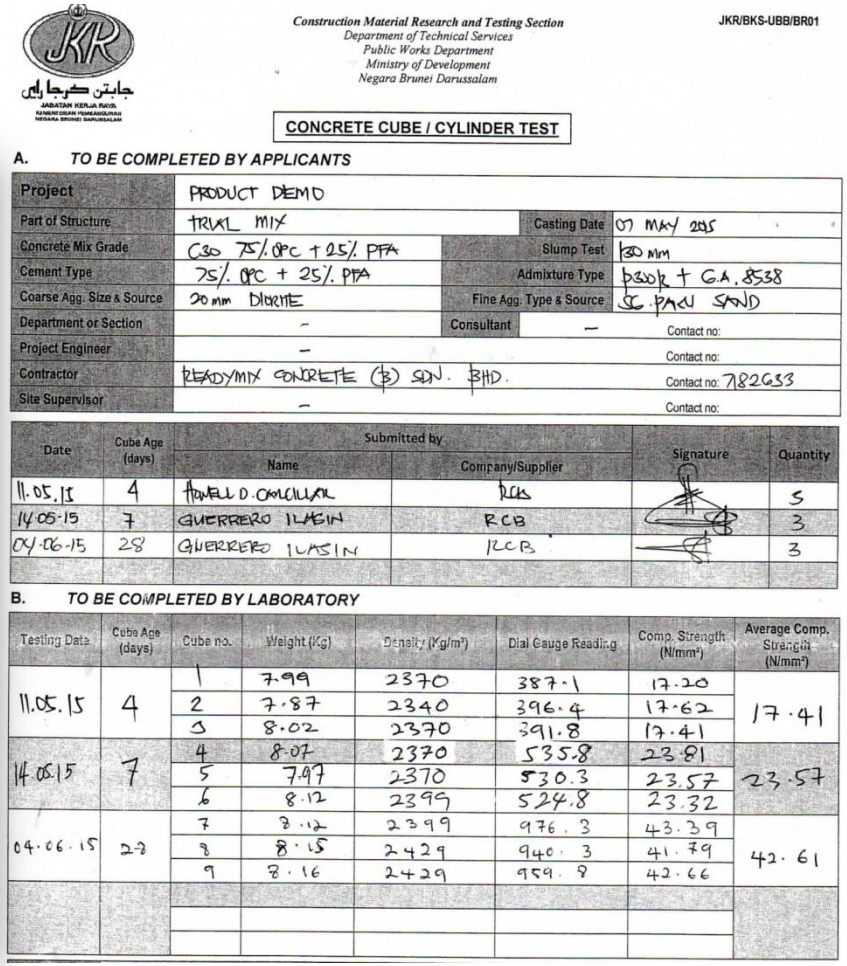
READYMIX EXPERIENCE

Test Results (75% OPC + 25% PFA)

Grade 30







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CONCRETE CUBE / CYLINDER TEST

A. *TO BE COMPLETED BY APPLICANTS*

Project	PRODUCT DEMO		
Part of Structure	TRIAL MIX	Casting Date	07 MAY 2015
Concrete Mix Grade	C30 75% OPC + 25% PFA	Slump Test	130 MM
Cement Type	75% OPC + 25% PFA	Admixture Type	P300R + G.A. 8538
Coarse Agg. Size & Source	20 mm DIORITE	Fine Agg. Type & Source	SG PASU SAND
Department or Section	–	Consultant	– Contact no:
Project Engineer	–		Contact no:
Contractor	READYMIX CONCRETE (B) SDN. BHD.		Contact no: 782633
Site Supervisor	–		Contact no:

Date	Cube Age (days)	Submitted by		Signature	Quantity
		Name	Company/Supplier		
11.05.15	4	HOWELL D. CONCILLAR	RCB		5
14.05.15	7	GUERRERO ILASIN	RCB		3
04.06.15	28	GUERRERO ILASIN	RCB		3

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Testing Date	Cube Age (days)	Cube no.	Weight (Kg)	Density (Kg/m³)	Dial Gauge Reading	Comp. Strength (N/mm²)	Average Comp. Strength (N/mm²)
11.05.15	4	1	7.99	2370	387.1	17.20	17.41
		2	7.87	2340	396.4	17.62	
		3	8.02	2370	391.8	17.41	
14.05.15	7	4	8.07	2370	535.8	23.81	23.57
		5	7.97	2370	530.3	23.57	
		6	8.12	2399	524.8	23.32	
04.06.15	28	7	8.12	2399	976.3	43.39	42.61
		8	8.15	2429	940.3	41.79	
		9	8.16	2429	959.8	42.66	

READYMIX EXPERIENCE

Physical Appearance

READYMIX EXPERIENCE

Physical Appearance

READYMIX EXPERIENCE

More local testing @ BHC

READYMIX EXPERIENCE

First Commercial Delivery : 1 April 2016

Quality Is Our Strength

Around the world

It started more than 2,000 years ago…

The ash generated from Volcanoes was used extensively in the construction of Roman structures.

Colosseum is a classic example of durability achieved by using volcanic ash.

This is a building constructed 2,000 years ago and still standing today!

Around the world

Ghatghar Dam

But the Ghatghar Roller Compacted Concrete Dam was a unique project in all respects. For the upper dam, 65% fly ash was used with 35% Portland cement. The result was much better than expected.

So Fly Ash was increased to 70% with only 30% of Portland cement!! Of course, this was possible due to the roller compacting technology employed and definitely not be advised for other regular structures. Though, it is amazing to see how the younger one turns into the Big Brother and carries the elder one in his arms!!

Around the world

Burg-Al-Khalifa, Dubai

Concrete used

15

- High performance concrete(HPC)
- Low permeability
- High durability
- C80-C60 cube strength concrete was used
- It includes fly ash, Portland cement
- Two largest concrete pumping machines in the world were used for this purpose
- For reducing cracks due to high temperature concreting was done only at night
- So that air is cooler and humidity is higher with ice added to the mix

http://www.slideshare.net/jojikulangara/burj-khalifamode-of-construction

SUMMARY – WHY FLY ASH

- ✓ It delays the heat of hydration and hence reduces the thermal cracks in concrete
- ✓ It improves the workability of concrete
- ✓ It makes the mix homogeneous and hence reduces segregation and bleeding
- ✓ The concrete finish is improved due to perfectly spherical fly ash particles
- ✓ The concrete permeability is substantially reduced which enhances the life of the structure
- ✓ Fly ash contributes to the long term strength in concrete

CLOSING

READYMIX

Engineers urged to rebuild mindset to face challenges

From Page One

the 'specifications' that have been agreed upon.

He said that the ministry often encounters 'over specs' leading to wastage and decline in the capacity or durability of the project.

He said, "The ministry welcomes every improvement in the skills of its officers and employees as it will not only add value to the organisation but also equip them with knowledge which is relevant to their respective career or work responsibilities".

The minister emphasised on improving the design, technology and building materials to overcome the challenges posed by on-site accidents and natural disasters.

"The construction industry is a very complex field not because of its major role in science and technology, but as an industry which prioritises Health, Safety and Environment (HSE).

"It is essential for young engineers to strive for enhancing their technical skills so that they can produce high quality work and manage and supervise construction projects efficiently," he added.

SALES ENQUIRIES

READYMIX

SALES MANAGER

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