DURA® - Ultra-High Performance 'ductile' Concrete (UHPdC)

"Dura Technology Sdn. Bhd. is proud to introduce an advanced construction material engineered to be extremely durable and environmentally friendly and to inspire the creation of innovative building elements".

DURA® is a new generation Ultra-High Performance construction material suitable for use in the production of precast elements for civil engineering, structural and architectural applications.

DURA® is a concrete without coarse aggregates which can attain compressive strengths of 150 MPa and beyond. Its unique blend of steel fibres and cementitious binders with a low water content give DURA® the extraordinary characteristics of high compressive flexural strengths, ductility and durability.

DURA® will ignite the imagination of designers in their quest to unite form and function.

DURA®

like concrete • like steel

QUICK FACTS

◘ Dura® is typically 5 times stronger than Grade 30 concrete.

◘ Dura® is at least 30 times more durable than Grade 60 marine concrete.

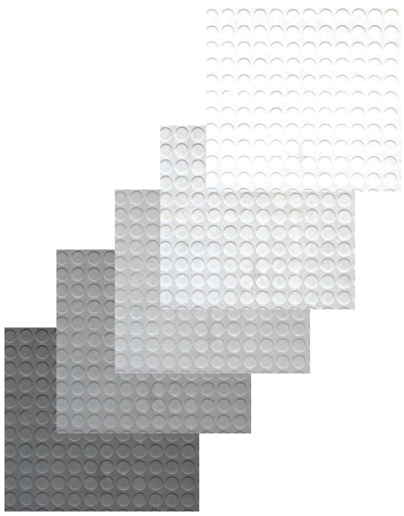
◘ Dura® is at least 120 times higher in fracture energy than any conventional concrete. This means, for example, significantly better impact resistance & ductility.

◘ Structures & elements made from Dura® is half the volume and weight of conventional concrete elements.

◘ Dura® is a green material and supports the concept of sustainable development.

◘ Dura® is an economical solution for life-cycle cost performance.

◘ Dura® is an ideal material for Archi-Structural design.

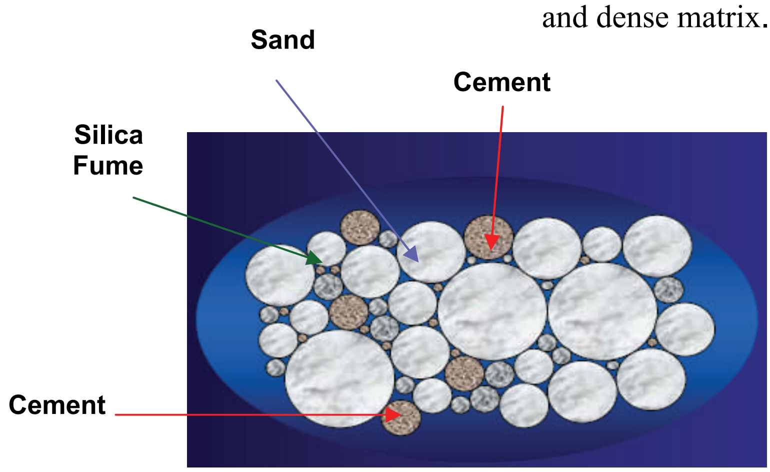


APPLICATIONS

- **Infrastructure**: Ultra light and slender sections for pedestrian and highway bridges.
- **Impact resisting structures**: Security panels against impact, seismic and blast loads, crash safety barriers.
- **Prestressed elements**: Piles, culverts, retaining-walls, pipes, safety-vaults etc.
- **Buildings**: Ultra-slender beams, slabs and column system; long span floors and roofs, thin façade panels.
- **Others**: Architectural features, acoustic barriers, structural walls, marine/sea walls and decks, anchorage plates, leave in-place forms/moulds, containers, manhole covers, storage tanks.

◘ MICROGRANULAR TECHNOLOGY

The very dense concrete matrix of Dura® is realized through the application of microgranular technology which uses various compounding ingredients to fill up gaps between coarser particles. This results in minimal micro-voids formation and creates a very closely packed and dense matrix.

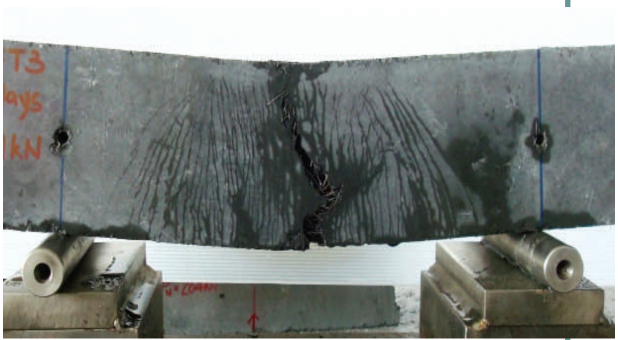


DURA® - UHPdC

Dura® – is the trade name for our our blend of Ultra-High Performance 'ductile' Concrete (UHPdC), formulated by combining a blend of Portland cement, silica fume, fine silica sand, additives and very high strength steel fibres. This material delivers 28 days compressive and flexural strength of up to 150 MPa and 30 MPa, respectively, in 28 days, and has ductility and durability performances well beyond conventional concrete. Below are the key features of Dura®:

1. Durability Performance

Dura® is a material with very small and discontinuous pores which prevents the movement of vapours within the concrete matrix resulting in a permeability index of less than one-tenth of conventional concrete. The combination of its chemical & physical structure produces a dense and hard matrix making it highly resistant to weathering, chemical attack, hydraulic scouring and salt-water ingress. Hence, coating or painting is unnecessary.



2. Ductility Performance

The use of ultra-high strength steel fibres gives DURA® a flexural toughness comparable to structural steel. The flexural strength at first crack ranges from 10 to 12 MPa, with ultimate flexural strengths of 15 to 35 MPa, being achieved. Experimental studies have shown that crack widths are no more than 0.05 mm and 0.5 mm at serviceability and ultimate limit states, respectively. (No fibre fracture was observed at all stages of cracking.) The picture above, shows multiple closely-spaced fine cracks that demonstrate the superior ductility of Dura®. This ability to redistribute stresses cannot be achieved with conventional concrete.

3. Aesthetics

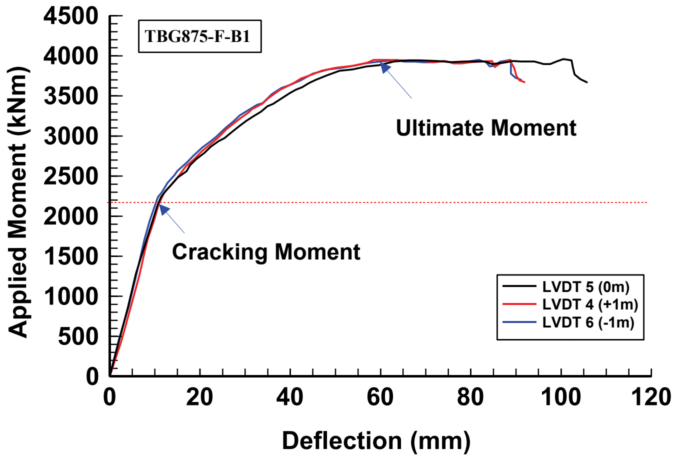
Due to the absence of coarse aggregate, improved homogeneity and optimized granular-packing of the concrete matrix, precast elements made from Dura® are able to achieve outstanding finishes when compared to conventional concrete. Designers are also able to create elegant solutions such as the 3.5-meter tall free-standing Dura® acoustic wall panels (see picture on the right) which are only 25 mm in thickness. Painting or coating is also not required as the natural fair-face concrete finish will retain its charm over time.

4. Workability

Despite its very low water-binder ratio of 0.15, DURA® exhibits extremely good flowability and behave like self-consolidating concrete. Some professional even refer to this as "liquid stone". This enables the casting of very thin elements.

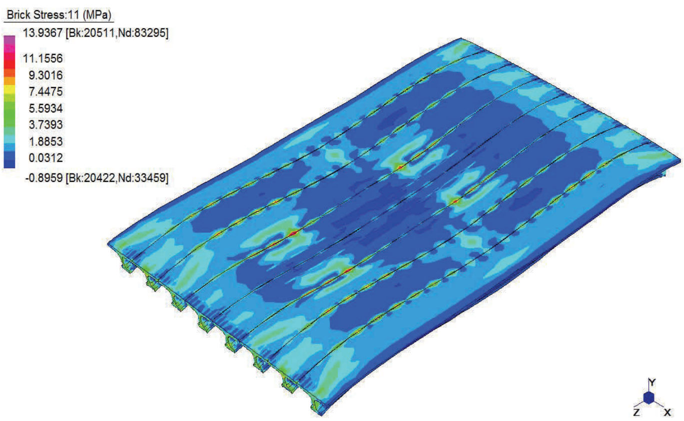
5. R&D

Dura's technology was built through extensive R&D. All our products undergo proper study and extensive testing in our laboratory before roll-out. We are committed to ensure that our team is kept up to date with the latest developments in UHPdC technology as we continue to develop new applications.



6. Design & Analysis

The technology is not limited to the material itself but also include the structural design and analysis of products made with the material. Taking into consideration that UHPdC is a relatively new material, a tremendous amount of effort has been invested into R&D and design methods to enable us to come out with optimized designs that take full advantage of the material's attributes. Extra care is taken to ensure that Dura® products are designed within a generous margin of safety due to its relatively short track record.



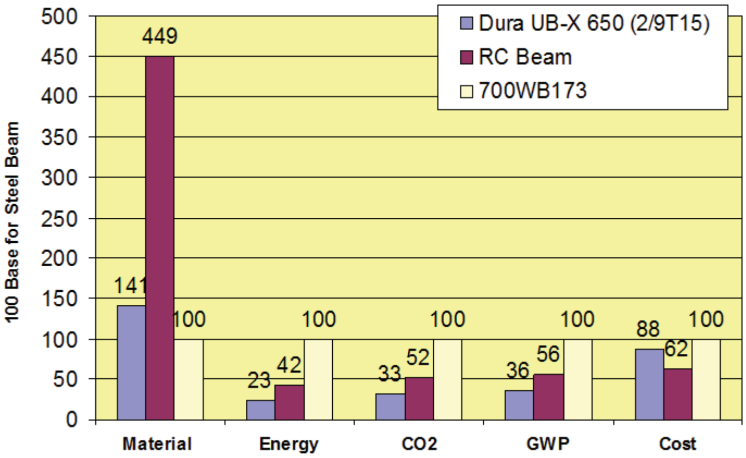
7. Engineering Maximization

Dura® 's unique combination of superior strength and ductility facilitates the design of structures with longer spans and thinner sections, resulting in overall lighter structures. For example, the picture on the right shows a 50m single span by 1.95m deep Dura® composite motorway bridge.

Scientists believe that carefully designed projects can lead to a service life of 200 years or more and up to 70% savings on total life-cycle cost.

8. Sustainability

Experts worldwide warn that the problem of Global warming, which is caused by excessive CO_2 released into the atmosphere, is the most devastating problem human beings are facing today.



Dura® consumes less materials and energy; thus contributes less CO_2 to the atmosphere when compared to conventional building materials such as structural steel or reinforced concrete.

In this way, Dura® supports the concept of sustainability.

"We did not inherit the world from our ancestors, we are borrowing it from our grand-children". - Anon

The rapid rate of CO_2 emission is causing alarm throughout the world. The cement and construction industries are acknowledged as major contributors to the total of 100 billion tonnes of CO_2 emission per year.

While human development activity would inevitably continue, the concept of "SUSTAINABLE DEVELOPMENT" has been adopted in recent years to mitigate the impact of such activities by applying methods that reduce emission of CO_2.

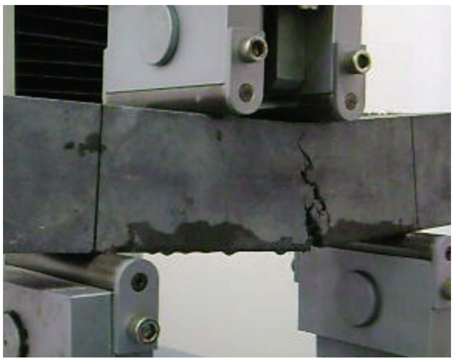
SUSTAINABLE • DUCTILE • DURABLE

Table 1: Material characteristics comparison of Dura® against normal strength concrete (NSC) and high performance concrete (HPC).

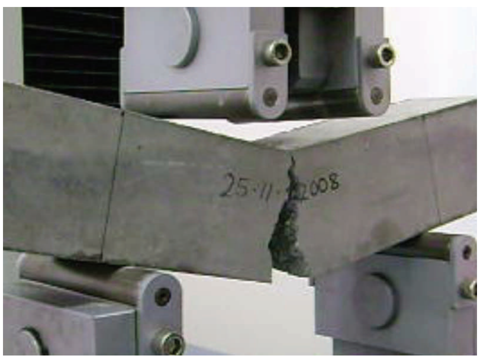
Characteristics	Unit	Codes / Standards	NSC	HPC	DURA®
Specific Density	kg/m^3	BS1881:Part 114-1983	2300	2400	2350 – 2450
Cylinder Compressive Strength	MPa	AS1012.9-1999	20 – 50	50 – 100	120 – 160
Cube Compressive Strength	MPa	BS6319: Part 2-1983	20 – 50	50 – 100	130 – 170
Creep Coefficient		AS1012.16-1996	2 – 5	1 – 2	< 0.5
Post Cured Shrinkage	$\mu\varepsilon$	AS1012.16-1996	1000 – 2000	500 – 1000	< 100
Modulus of Elasticity	GPa	BS1881:Part 121-1983	20 – 35	35 – 40	40 – 50
Poisson's Ratio			0.2	0.2	0.2
Split Cyl. Cracking Tensile Strength	MPa	BS EN 12390-6:2000	2 – 4	4 – 6	6 – 10
Split Cyl. Ultimate Tensile Strength	MPa	BS EN 12390-6:2000	2 – 4	4 – 6	10 – 18
Flexural 1st Cracking Strength	MPa	ASTM C1018-1997 ↑	2.5 – 4	4 – 8	8 – 12
Modulus of Rupture	MPa		2.5 – 4	4 – 8	18 – 35
Bending Fracture Energy, $G_{f,\delta=0.46mm}$	N/mm		0.05 – 0.10	0.06 – 0.18	1 – 2.5
Bending Fracture Energy, $G_{f,\delta=3.0mm}$	N/mm		0.05 – 0.10	0.06 – 0.18	10 – 20
Bending Fracture Energy, $G_{f,\delta=10mm}$	N/mm		0.05 – 0.10	0.06 – 0.18	15 – 30
Toughness Indexes I_5			1	1	4 – 6
Toughness Indexes I_{10}			1	1	10 – 15
Toughness Indexes I_{20}			1	1	20 – 35
Modulus of Rupture	MPa	JCI-S-002-2003 ↑↑	2.5 – 4	4 – 8	18 – 35
Bending Fracture Energy, $G_{f,\delta=0.46mm}$	N/mm		0.05 – 0.10	0.06 – 0.18	1 – 2.5
Bending Fracture Energy, $G_{f,\delta=3.0mm}$	N/mm		0.05 – 0.10	0.06 – 0.18	10 – 20
Bending Fracture Energy, $G_{f,\delta=10mm}$	N/mm		0.05 – 0.10	0.06 – 0.18	15 – 30
Rapid Chloride Permeability	coulomb	ASTM C1202-2005	2000 – 4000	500 – 1000	< 200
Chloride Diffusion Coefficient	m^2/s	ASTM C1556-2004	$4 – 8 \times 10^{-12}$	$1 – 4 \times 10^{-12}$	$0.05 – 0.1 \times 10^{-12}$
Carbonation Depth	mm	BS:EN 14630-2003	5 – 15	1 – 2	< 0.1
Abrasion Resistance	mm	ASTM C944-1999	0.8 – 1.0	0.5 – 0.8	< 0.03
Water Absorption	%	BS1881:Part 122-1983	> 3	1.5 – 3.0	< 0.2
Initial Surface Absorption	$ml/(m^2s)$	BS1881:Part 208-1996	0.7 (10 min) 0.2 (120 min)	0.1 (10 min) 0.05 (120 min)	< 0.02 (10 min) < 0.01 (120 min)

↑ Three-pooint bending using un-notched 100 x100 x 300mm specimen
↑↑ Four-point bending using notched 100 x 100 x 300 mm specimen

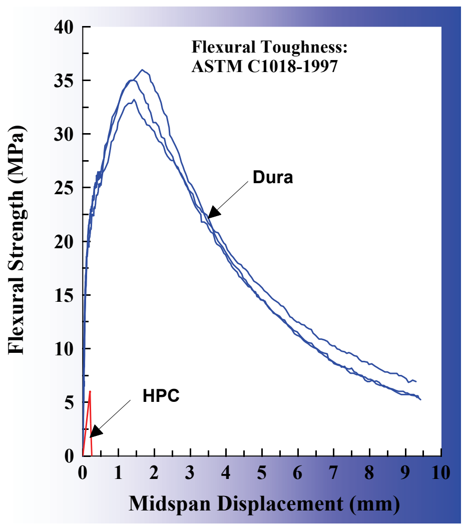
Flexural Test (100 x 100 x 300mm span)



Dura®



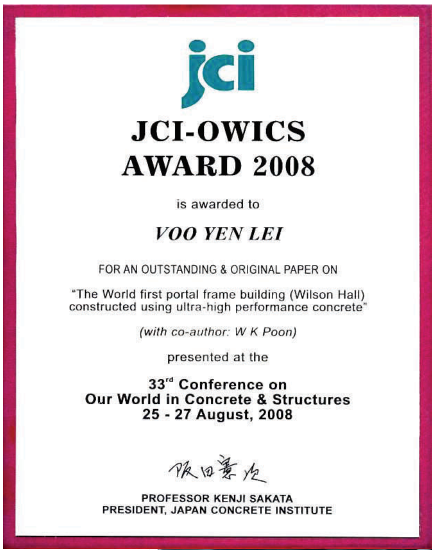
Grade60 HPC



WILSON HALL - AWARD WINNING PAPER

Wilson Hall, located in Chemor, Perak is the world's first portal frame building built using UHPdC technology. Wilson Hall was designed and built with the aim of studying the feasibility and performance of DURA® precast elements in place of conventional steel elements in portal frame design.

The width and length of the building's roof were 67 m (220 ft) and 42.7 m (140 ft) respectively, producing a total roof coverage area of 2,861 m^2 (30,800 ft^2). Only 4 cantilevered DURA® portal frames spaced at 12.2 m (40 ft) centres were required to support the roof. The frames comprised a total of only 8 precast prestressed columns which were joined to the internal rafters and cantilever rafters using bolted connectors.


jci

JCI-OWICS
AWARD 2008

is awarded to

VOO YEN LEI

FOR AN OUTSTANDING & ORIGINAL PAPER ON

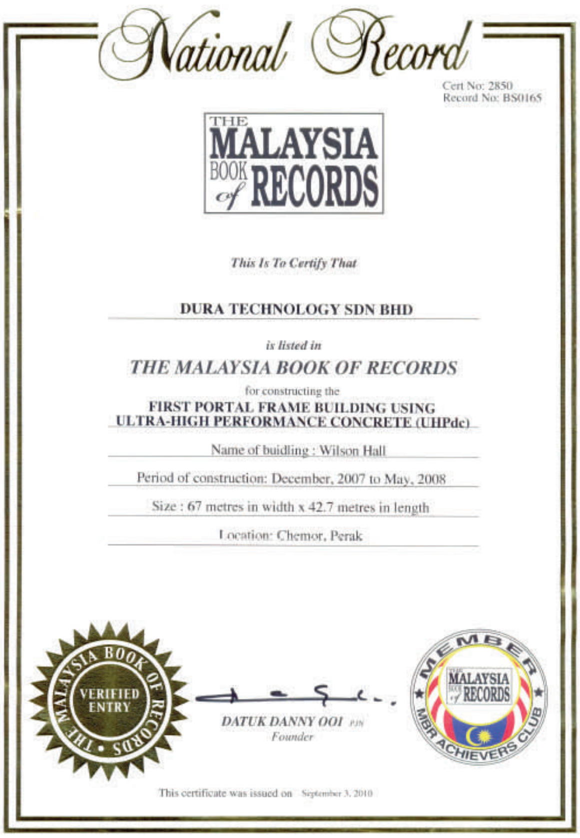
"The World first portal frame building (Wilson Hall) constructed using ultra-high performance concrete"

(with co-author: W K Poon)

presented at the

33rd Conference on
Our World in Concrete & Structures
25 - 27 August, 2008

PROFESSOR KENJI SAKATA
PRESIDENT, JAPAN CONCRETE INSTITUTE


National Record

Cert No: 2850
Record No: BS0165

THE MALAYSIA BOOK of RECORDS

This Is To Certify That

DURA TECHNOLOGY SDN BHD

is listed in

THE MALAYSIA BOOK OF RECORDS

for constructing the
FIRST PORTAL FRAME BUILDING USING
ULTRA-HIGH PERFORMANCE CONCRETE (UHPdc)

Name of buidling : Wilson Hall

Period of construction: December, 2007 to May, 2008

Size : 67 metres in width x 42.7 metres in length

Location: Chemor, Perak

THE MALAYSIA BOOK OF RECORDS • VERIFIED ENTRY

DATUK DANNY OOI
Founder

MEMBER MALAYSIA BOOK of RECORDS MBR ACHIEVERS CLUB

This certificate was issued on September 3, 2010

Dura® opens the door for ARCHI-STRUCTURAL design

Conventional reinforcing bars are unnecessary for Dura® due to it high flexural capacity and ductility. This mean that the sectional thickness of DURA® elements can be reduced and the consequent weight is about one half of conventional concrete elements. The highly workable nature of Dura® allows it to be shaped and formed into many different design variations that cannot be realized with conventional concrete. From this perspective, the possibilities are almost unlimited for designers.

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