Sustainable Concrete Technologies for New Zealand - one company's perspective.

Leonard McSaveney
Golden Bay Cement

Golden Bay Cement

We Commit. We Do.

NZCS

The Portland Cement Works

Sustainability Issues Facing NZ Cement & Concrete

- **False perceptions & misinformation.**
- **Research data has not kept up with process improvements - always ask the supplier.**
- **Lack of NZ skills in Life Cycle Assessment.**
- **Global consensus takes time – Rio de Janeiro – Kyoto - Copenhagen…**

  But plant modifications also take time!

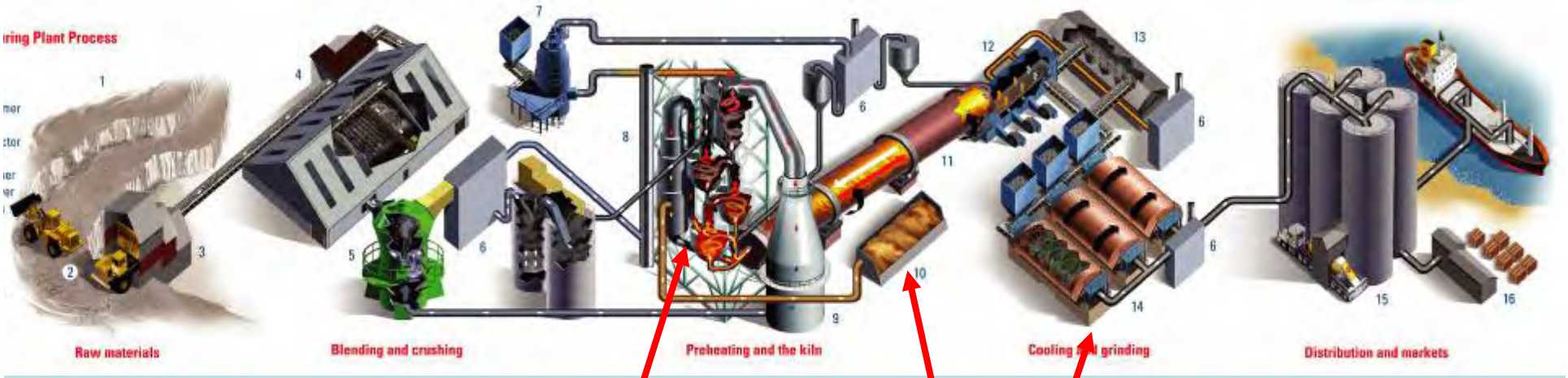
Opportunities for Improvements

1. The Portland cement manufacturing process
2. Clinker chemistry & grinding aids
3. Storage and distribution methods
4. Recycling & waste mitigation
5. Applications in Concrete…

GBC's Process Changes

- ✓ **Converted from wet to dry process in 1983.**
- ✓ **Modified plant to capture waste heat for pre-calcining and for fuel drying, in 2005.**
- ✓ **Modified to burn wood waste in 2004 - a carbon-neutral bio-fuel.**
- ✓ **Changed from open circuit milling to closed in 2008.**
- ✓ **Currently negotiating to increase the pozzolanic filler content to 10%.**
- ✓ **Cement blending capacity added in 2009.**

The Golden Bay Cement Process
(2008)



Pre-calciner

Closed Circuit Ball Mills

Bio-fuel storage

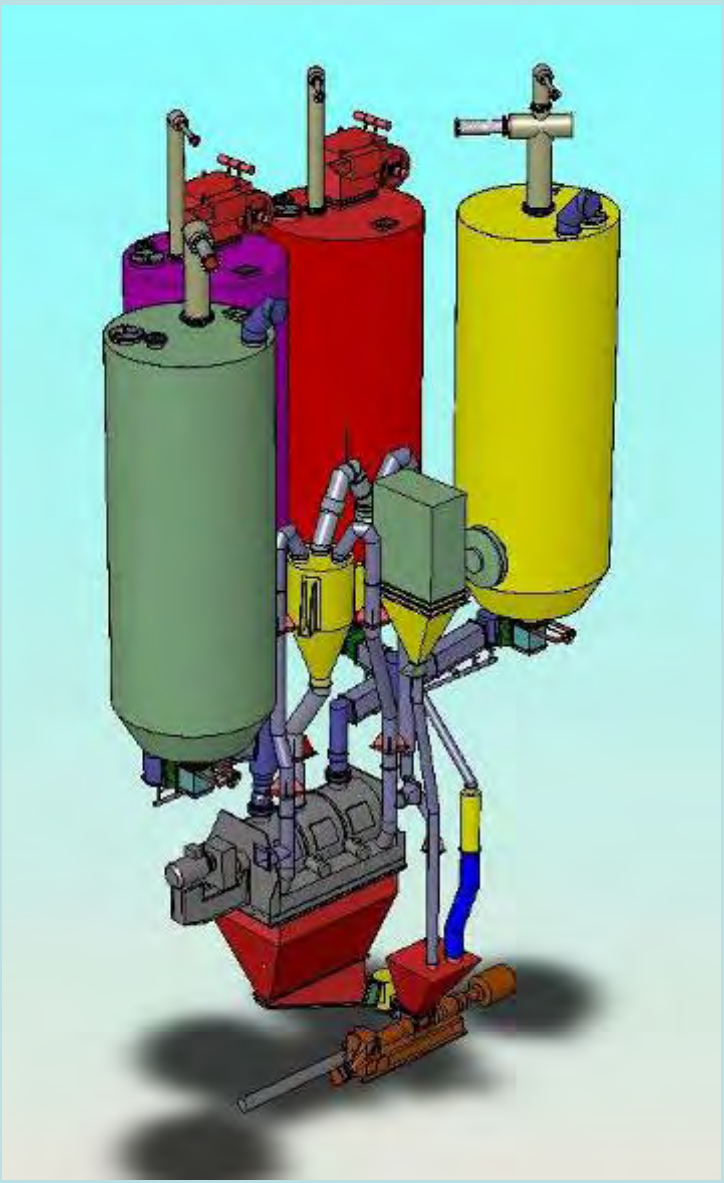
Relocation of GBC's Auckland Cement Depot

Concept to Reality

January - 2008

September - 2009

Eastport Blending plant



- **Can blend up to four components simultaneously**
- **Blended product can be prepared on a “per load” basis or stored in bulk, for a large order**

Blends

- Green Star rated – 20% non-kiln material
- Precast Green Star – 15% non-kiln
- Low Heat
- Chemically resistant
- Marine durability
- Self-Compacting mixes
- Masonry
- Hollow-core flooring
- Stabilization and grouting
- Other?

CO_2 Reduction

- **Fuel efficiency**
  - **Capture waste heat**
  - **Use pre-burnt limestone from waste products -**
    - **Fly Ash or KOBM Slag**
  - **Pre-dry fuel**
- **Bio-fuel**
  - **Wood waste – a Carbon Neutral fuel (Kyoto Protocol)**

Left to rot, wood waste forms methane with 23 times the global warming effect of CO_2!

Bio-fuel is Carbon-Neutral under the Kyoto Protocol.

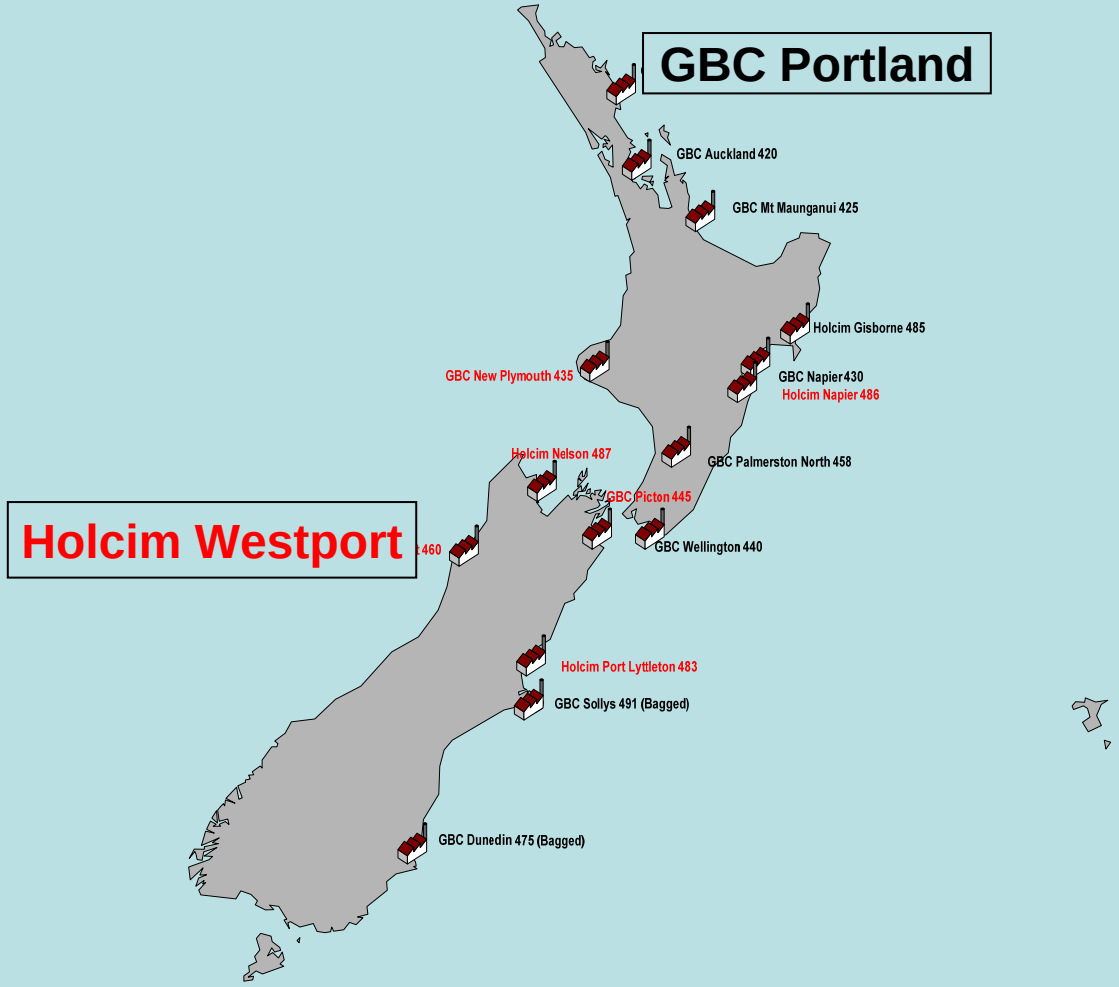
Geopolymer Concrete test slabs

Wood waste supplements the pre-calciner heating.

CO_2 Reduction

- **Storage & transport efficiency**
  - **Sea transport to regional hubs**
  - **Just-in-time road tanker transport to customers**
- **Reciprocal trade with Holcim to minimize ship movements**

New Zealand Service Centres



CO_2 Reduction

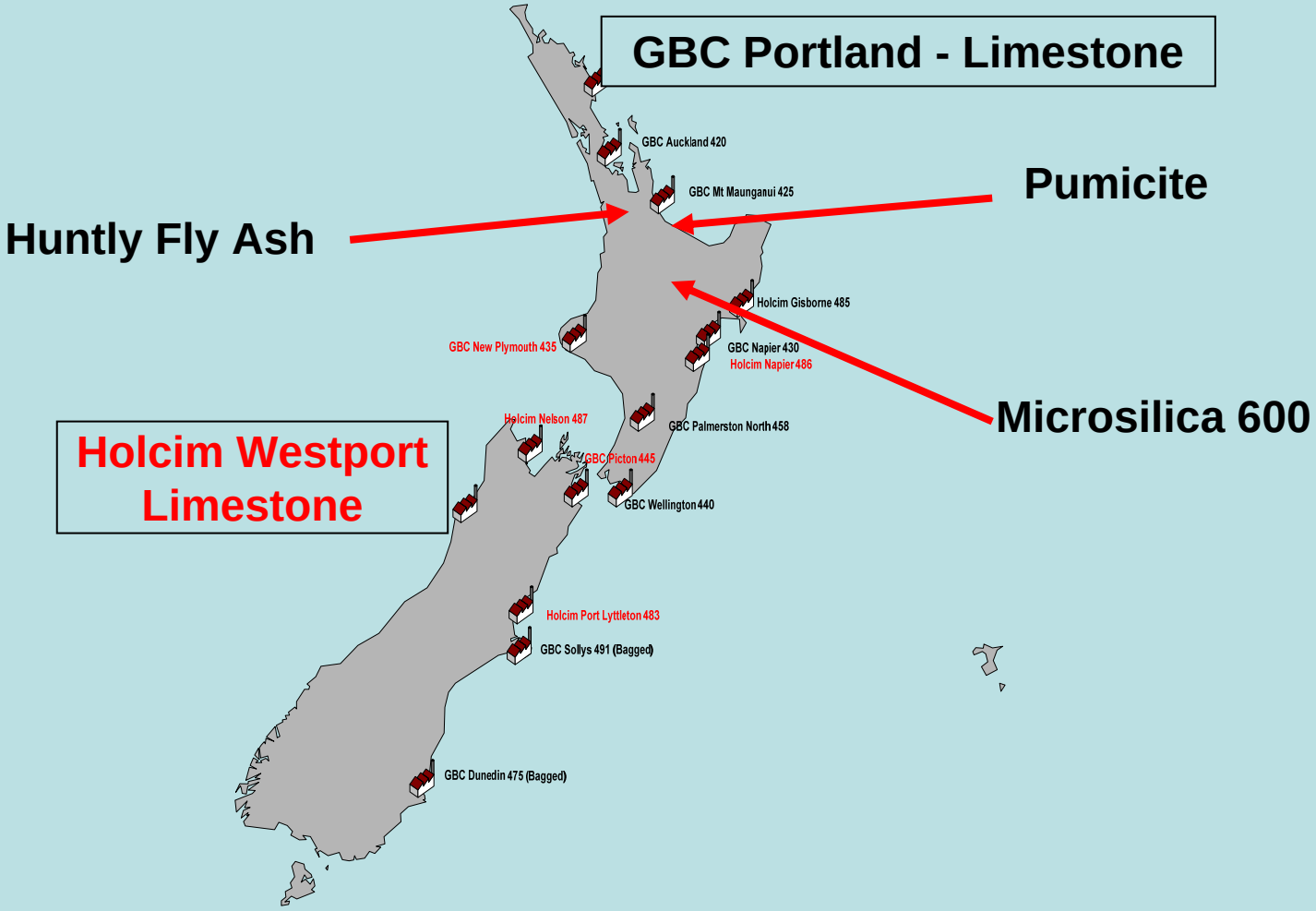
- **Pozzolanic Mineral Fillers:**
  - **Change the NZ Standard for GP cement, from 5% pozzolanic mineral filler, to 10%.**

With no noticeable loss of performance in Concrete.

Locally Available Pozzolans

- **Huntly Fly Ash – Class C**
- **Amorphous geothermal micro-silica**
- **Pumicite**
- **Limestone**
- **Diatomaceous earth**
- **Powdered glass**

Available New Zealand SCM's



Microsilica New Zealand

The Rotorua Quarry

Raw Material

- **Geologically, a hydro-thermally altered Rhyolite, deposited as pumice breccia.**
- **Originated from Mt Pirongia approximately 160,000 years ago.**
- **Deposit size approximately 2,000,000 tonnes.**
- **Operating life expectancy 140 years.**

Technical Data

- **Strength efficiency 3X**
- **50% passing 2 Micron**
- **Amorphous silica content >87%**
- **SO_3 content <0.03%**
- **Bulk density 0.5 t/m^3**
- **Standards:**
  - **NZS 3122**
  - **AS 3582**
  - **ASTM C 1240**

Microsilica 600 Chemistry

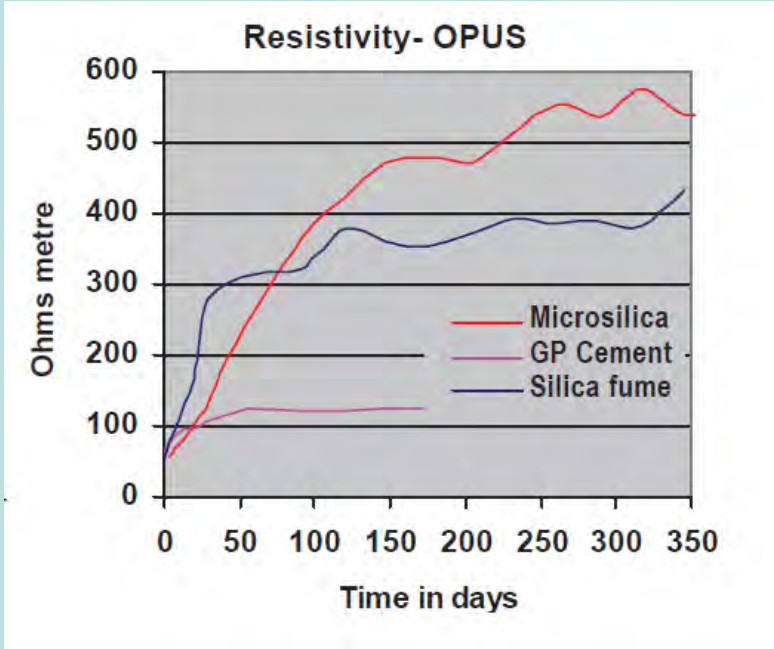
(Typical)

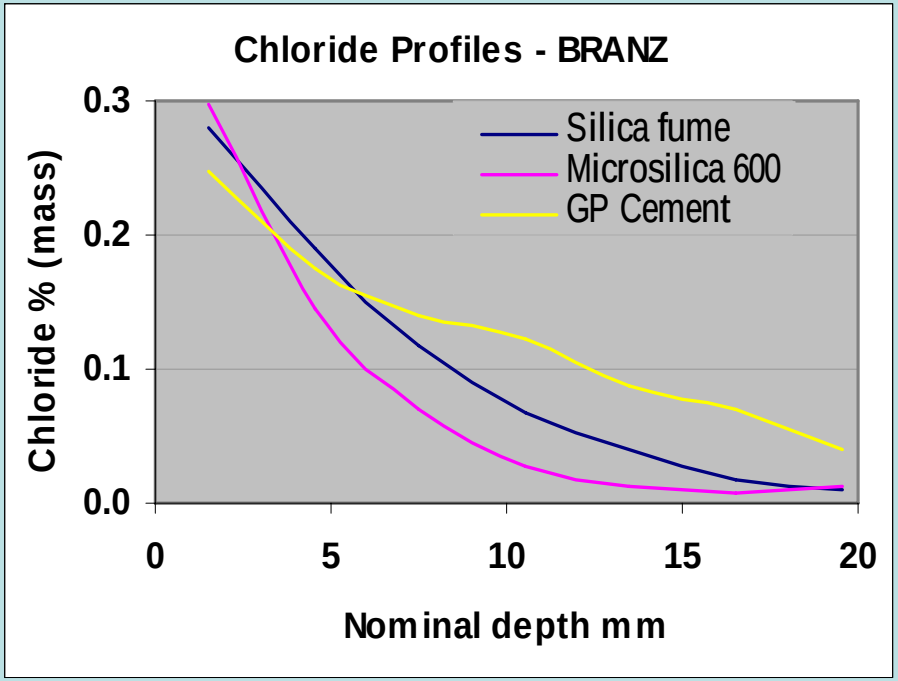
SiO_2	87.89 %	CaO	0.32 %
Al_2O_3	4.31 %	K_2O	0.49 %
SO_3	0.13 %	P_2O_2	0.05 %
Fe_2O_3	0.59 %	MgO	<0.02 %
MnO	0.03 %	Na_2O	0.14 %
TiO_2	1.16 %	LOI	5.01 %

Colour – White!

Available as a powder, or as a slurry.

Durability Parameters
MS 600





Chloride profiles - from 18 months in splash zone.
Easier to mix & handle that Silica Fume…

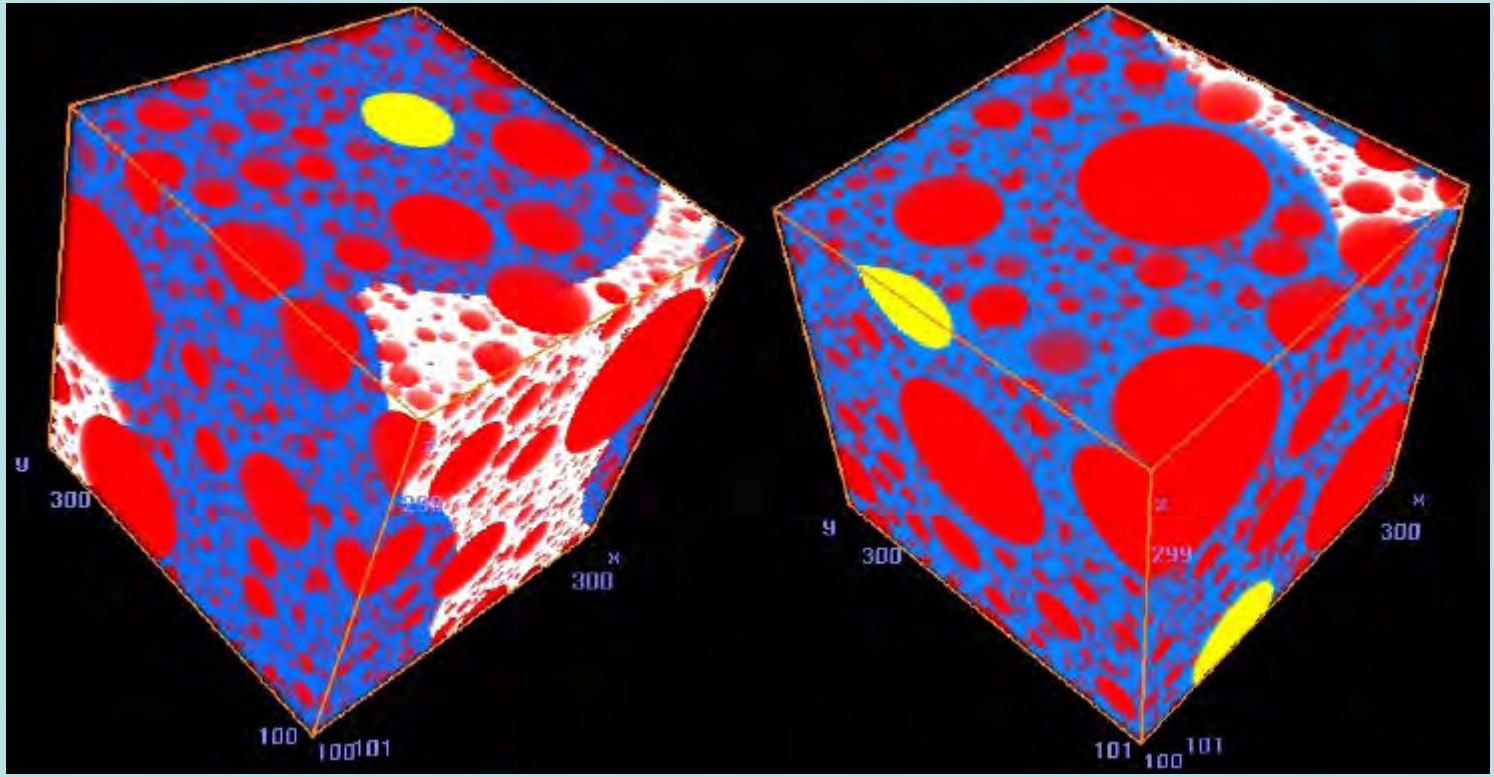
Pumicite – a by-product of pumice quarrying

Pumice Quarry – Te Puke

Why the Interest in Pumice?

- **Reduced precast concrete transport and erection costs – greater productivity.**
- **Improved durability – internal curing, etc.**
- **Avoid the high cost of imported LWA.**
- **Eliminate high Carbon Footprint of imported, kiln–derived LWA.**
- **A more sustainable product for NZ.**
- **Self-curing concrete.**

Internal Water Curing



Bentz et al. (2005)

Compression Test Results

Pumice LWC

Low Strength Mix

- w/c ratio ≈ 0.37
- f_c' = **24.3** MPa (28 Days)
- Density = **1610** kg/m^3
- Cohesive, good quality mix
- No segregation

Higher Strength Mix

- w/c ratio ≈ 0.21
- f_c' = **42.6** MPa (28 Days)
- Density = **1964** kg/m^3
- Cohesive, good quality mix
- Easier to mix & handle - could be SCC

The Wellington Fault

Reduced transport cost with LWC

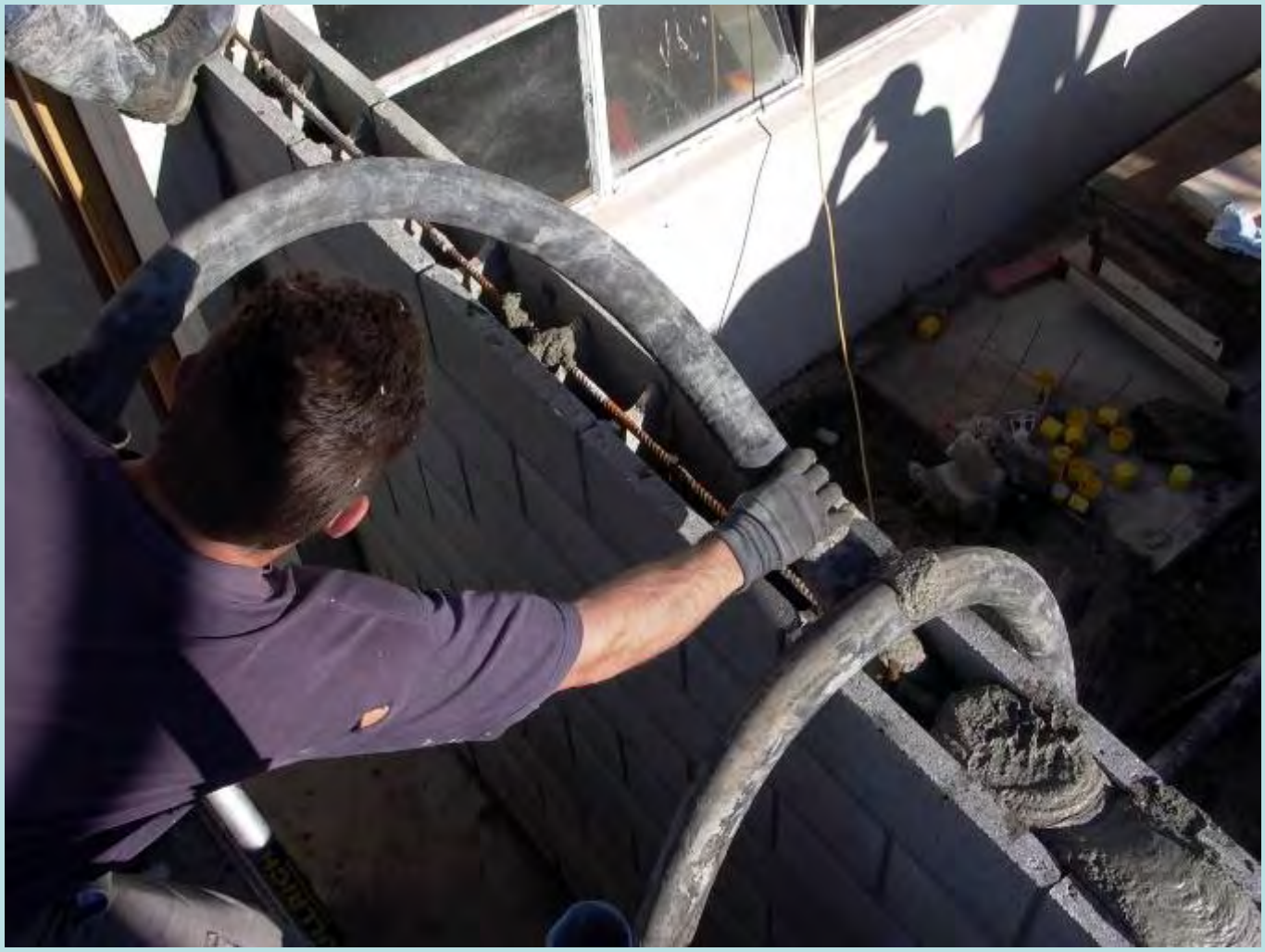
Durability of LWAC is enhanced by:

- **Pozzolanic action - this gives perfect paste to aggregate bond.**
- **Aggregate absorption prevents voids due to bleed-water and provides internal curing from moisture inside the aggregate. Perfect curing!**
- **Reduced micro-cracking under load, due to more compatible aggregate and paste stiffness.**

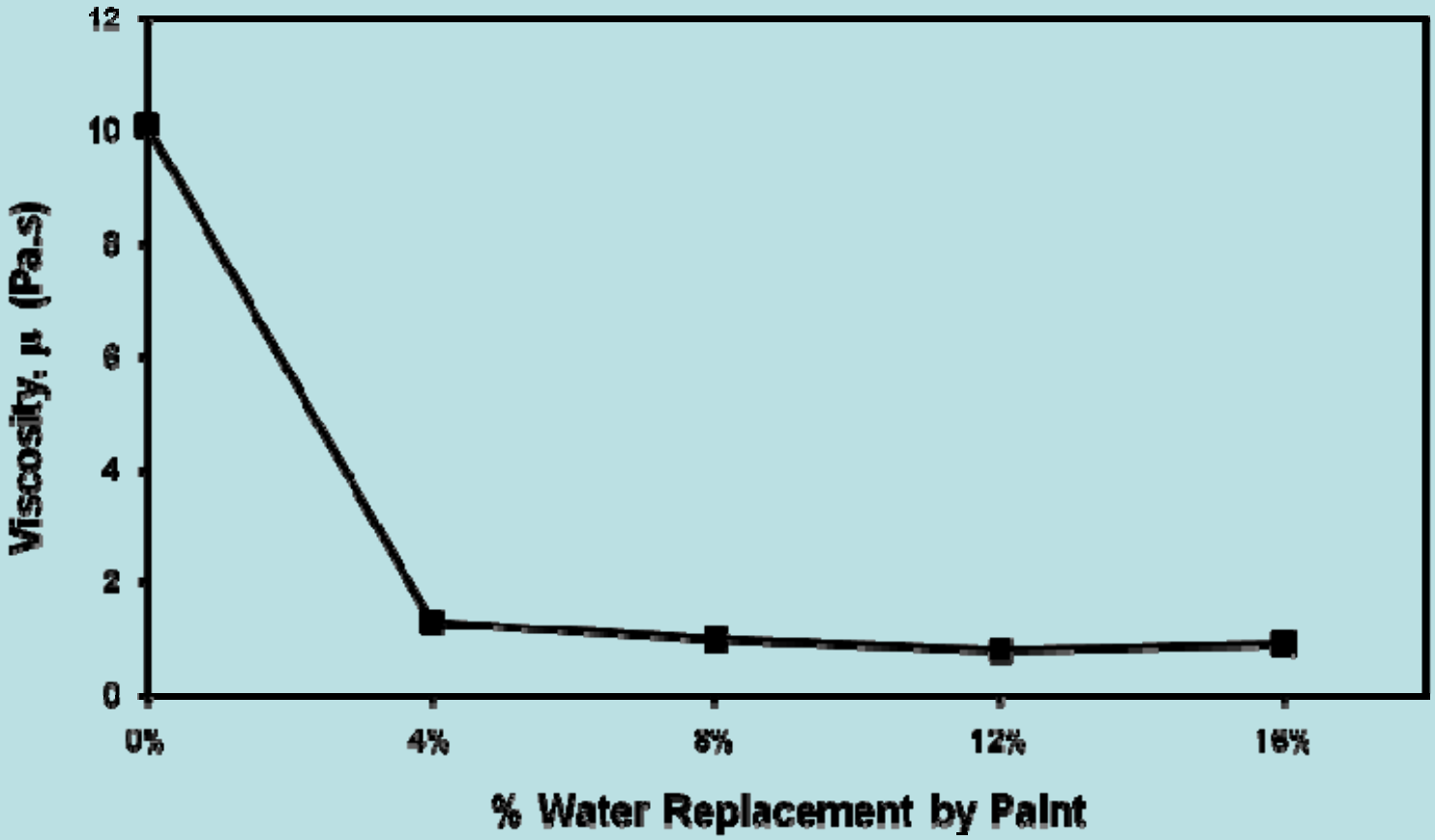
Waste Recycling

New Zealand has an excess amount of waste paint that was destined to end up in landfill…

PaintCrete Site Trials



Viscosity is greatly reduced for all paint concentrations



No bleeding & no settlement!

Concrete evidence that recycling pays dividends.

Golden Bay Cement and Firth Industries have joined with 3R and Resene's PaintWise programme to develop Paintcrete®. Waste paint previously destined for landfills will be used in various cement based applications. In other words it becomes a filler in concrete – and perfectly suitable for filling masonry walls (where the nasty mauve paint chosen by your colour-blind partner won't be noticed).

Extracting value from the most unlikely places.

Firth

Golden Bay Cement

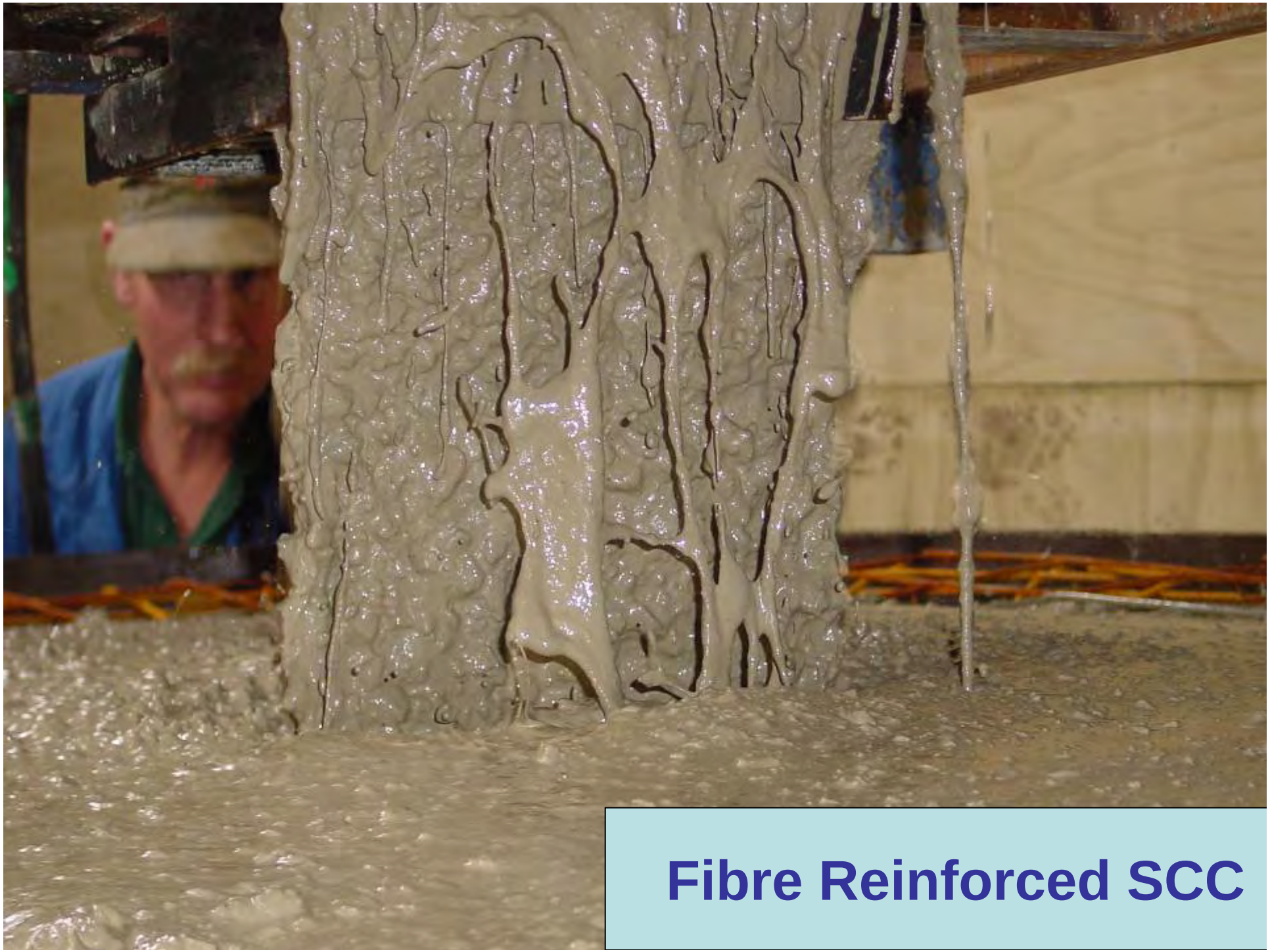
www.fletcherbuilding.co.nz | GENERATING RETURNS FOR FUTURE GENERATIONS

Inorganic Polymer Concrete

A new cement with low CO_2 Emissions…

Seismic Testing of a Beam-Column Joint

It is just like Portland Cement concrete!



Fibre Reinforced SCC

A waste-water treatment tank in fibre-reinforced SCC.

Three components:

- **Outer shell**
- **Inner baffles**
- **Top**

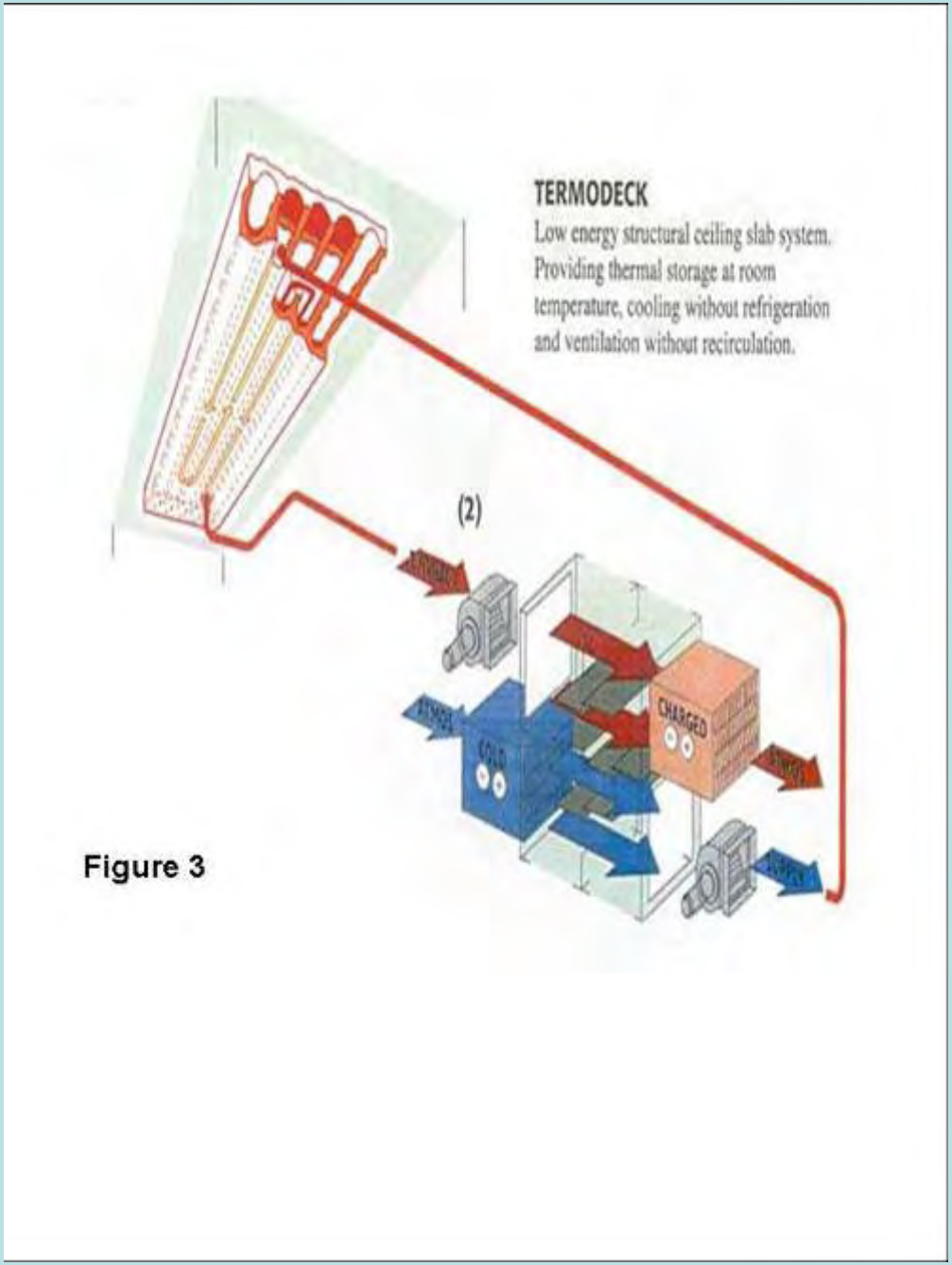


Figure 3

Encourage wider use of Thermal Mass

Human comfort response:
65% Radiant Heat
35% Conduction

Store heat in the structure and run buildings at a lower air temperature!

PRESSS Technology

Auckland Airport Parking Building

- **Low seismic damage, fast to erect and relocatable.**
- **Included in NZS 3101:2005 & Taught in Universities**

Old quarries become ideal Kiwi sanctuaries.