PB 0488

Sand from Surplus Quarry Material

4th of October, 2012

KAYASAND

The V7 Technology

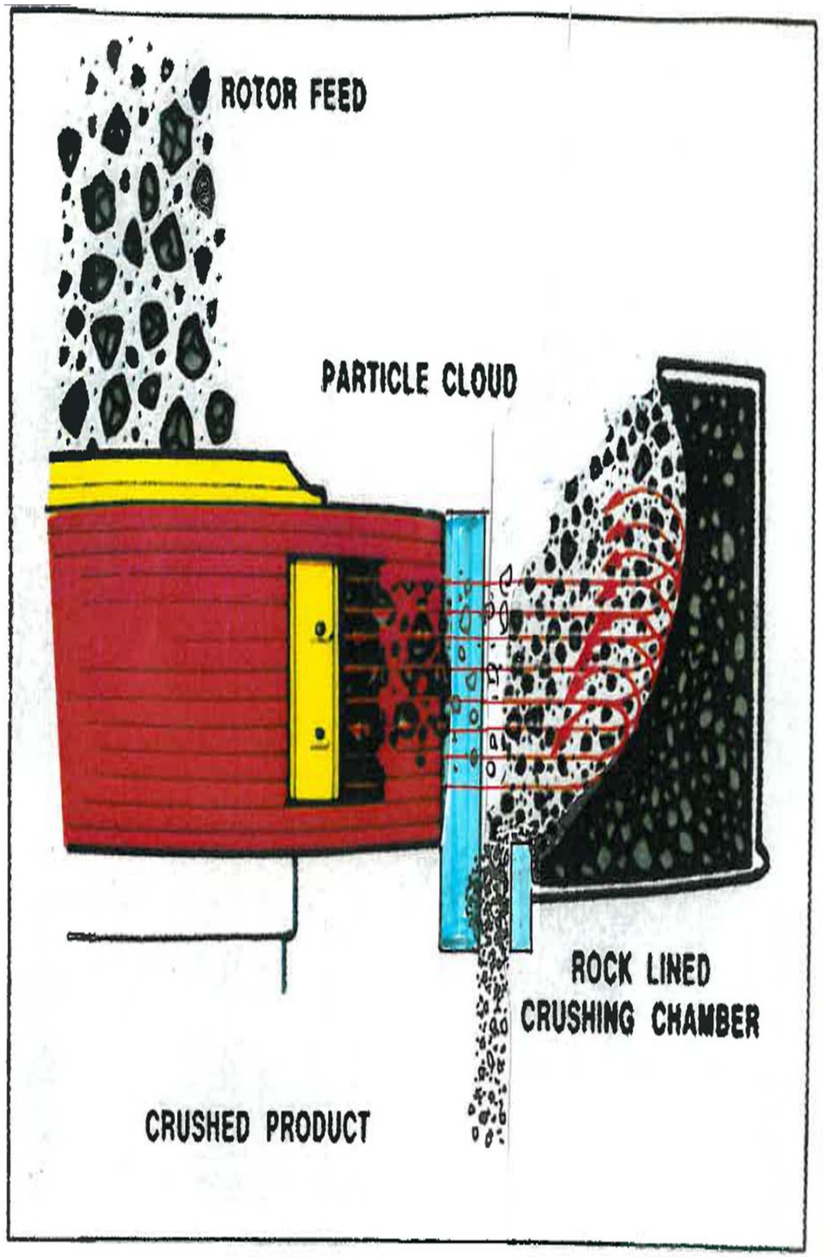
KEMCO

Unique Crushing System

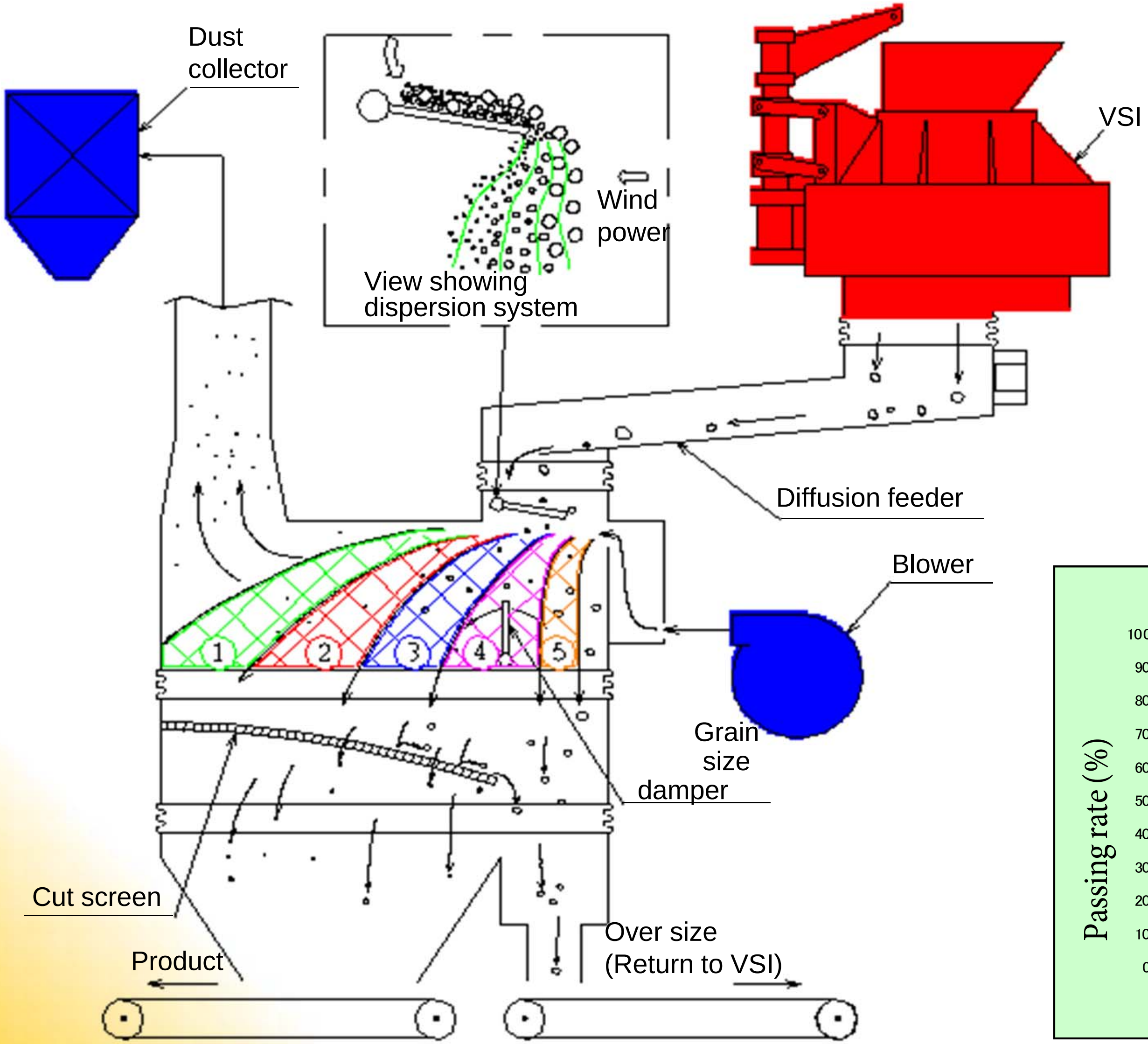
There is an autogenous crushing within the particle cloud and on the rock bed for both, the Barmac and V7 Crushers.

The V7 Crusher is constructed so there are multiple impacts in the new dense material zone.

As the material drops down from the stone wall into an increasingly dense zone, it is re-crushed by particle interaction as well as hammers, being both shaped and scrubbed.

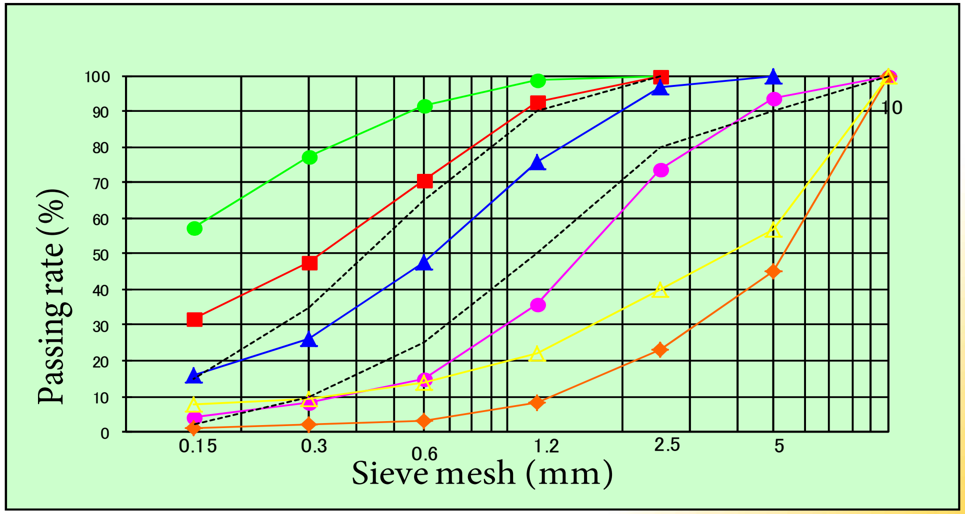


A Unique Separation System



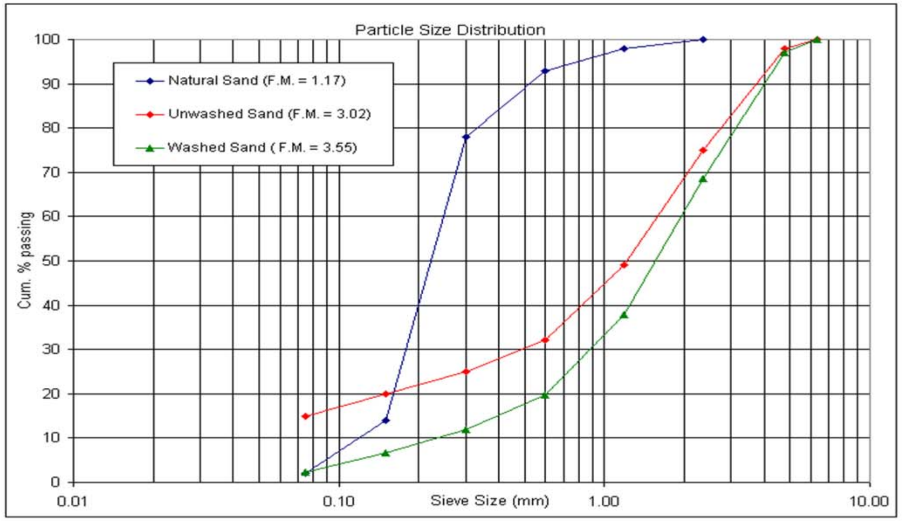
Inner structure of air screen

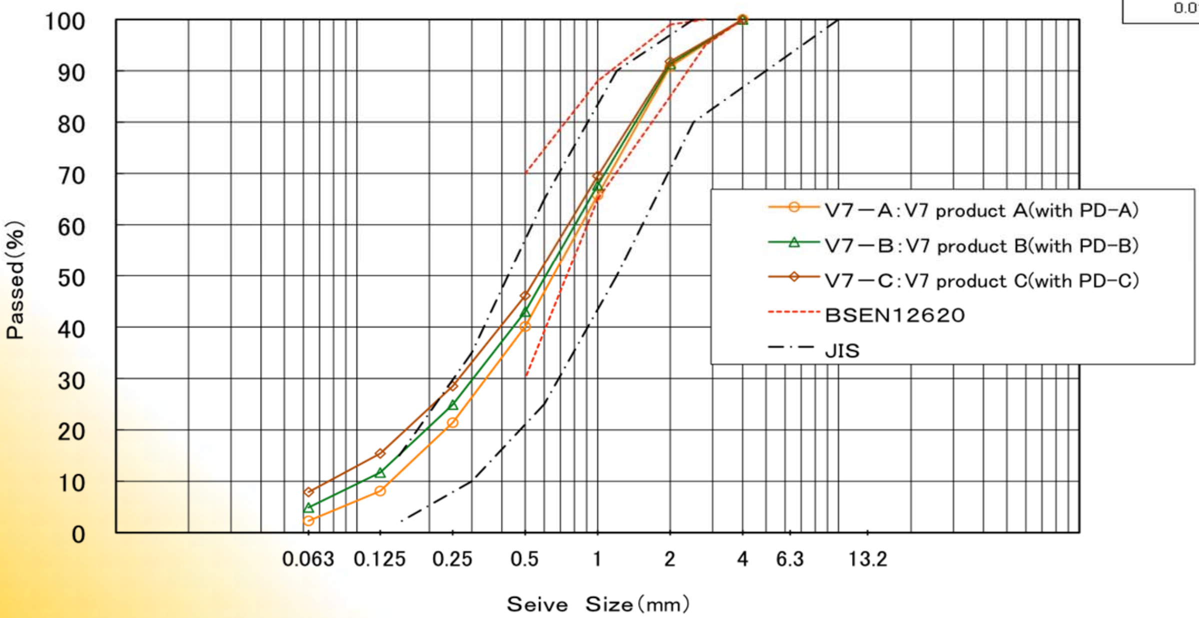
- Air screen gives partial return, top-size cut and classification.
- Raw material flows from VSI → diffusion feeder → air screen separation using the blower.
- (5) is fully returned, and (4) is partially returned by the damper.
- Top size (1) - (3) and part of (4) screened for oversize return.



Unique Flexibility in Gradation

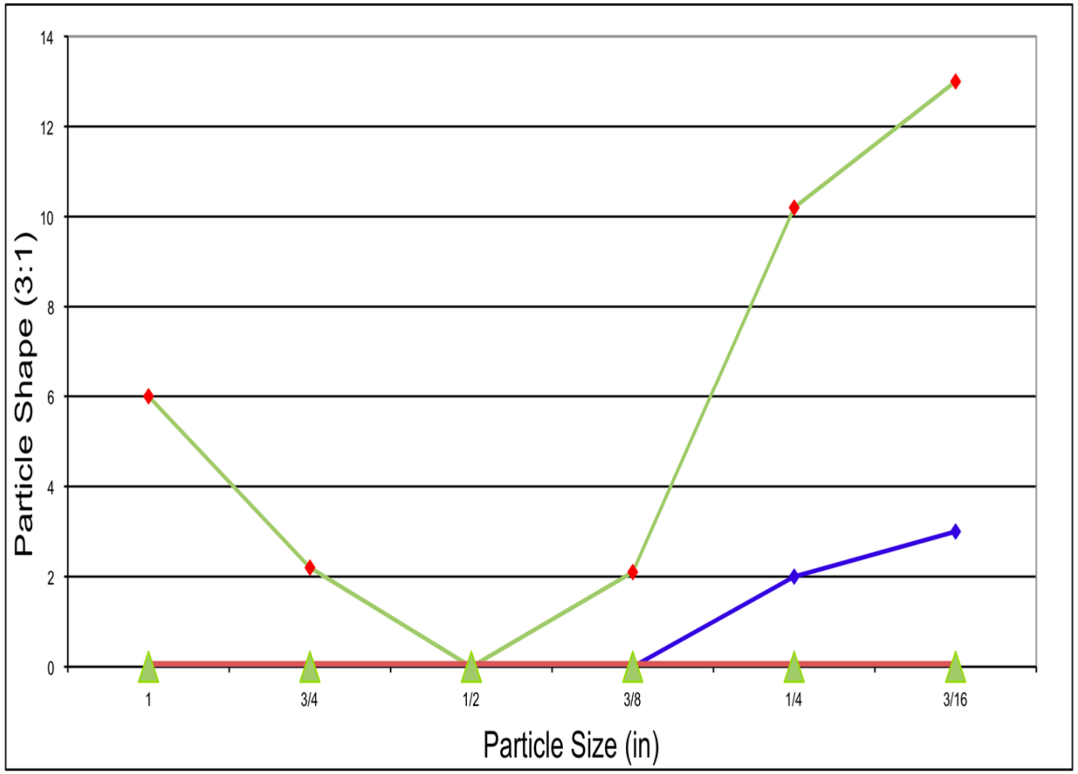
A poorly graded crusher dust becomes even poorer after the removal of filler by washing or dedusting.





Kayasand is evenly graded and gradations can be changed to make the ideal sand as a single fine aggregate component for concrete or asphalt.

Unique Shaping to 75µm



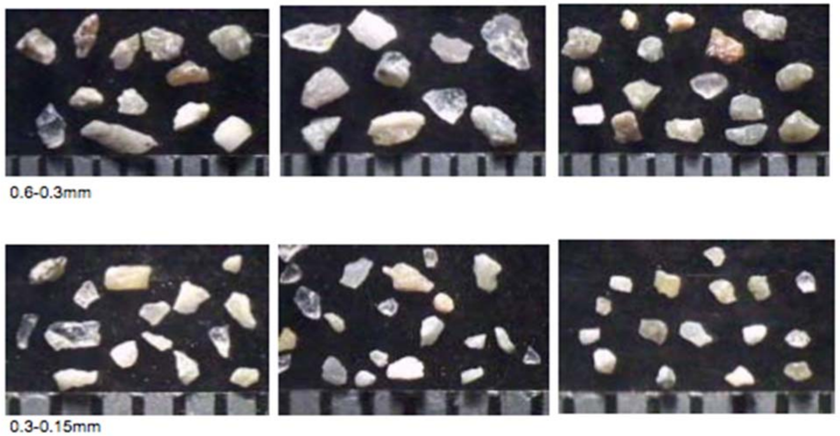
Shape of particles <1mm vital

- Workability
- Pumpability
- Density

Cone Crusher

Barmac VSI

V7 Crusher



Summary of Differences

- The V7 has a more efficient crusher than other autogenous VSI’s
- The V7 has an airscreen with the ability to recirculate a variable size of product
- The V7 can vary the gradation of the sand
- The V7 can control the minus 75 micron content of the sand
- The V7 produces a shaped particle size to 75 micron particles
- The V7 operates dry as well as quietly and dust free

Can V7 Kayasand **COMPLETELY** replace natural sand in concrete?

KAYASAND

Cardiff University Research

CARDIFF UNIVERSITY

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Key Objectives

- Primary aim to show that a manufactured sand can be made to replace natural sand and sand blends
- Secondary aim to refine gradations to reduce cement usage and to find new uses for rock filler in agriculture

Environmental Benefit

- If replacement is proven viable then dredging for sand can be reduced or eliminated, and viable concrete sands can be made in most quarries.

Project Details

- Ship material to Japan and return processed sand to Wales
- Concrete Research by Cardiff University's Engineering Department

Materials Tested

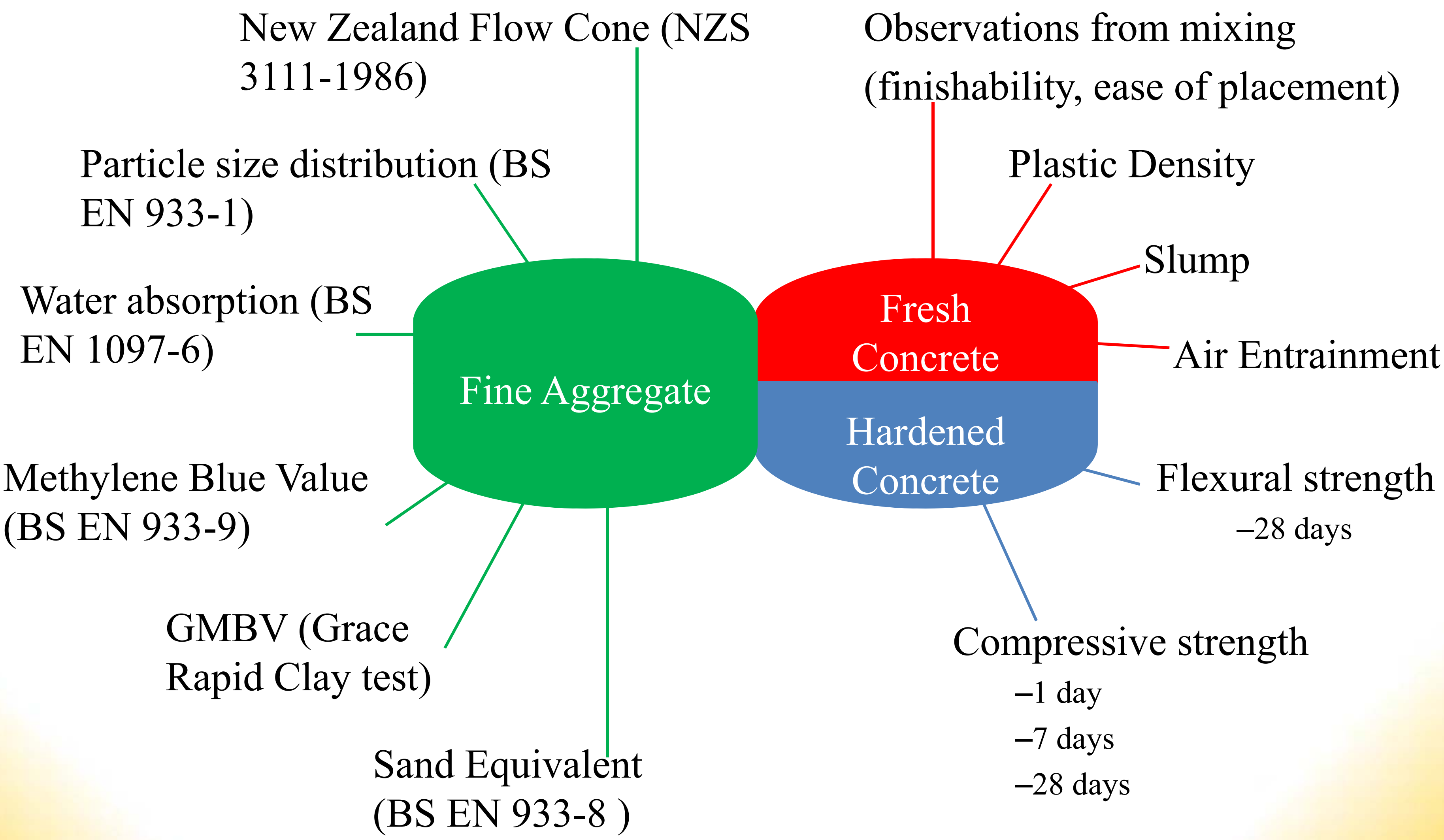
A well graded dredged sea sand from Bristol channel (N) was used as a control, and a 4/20mm crushed Limestone from Wenvoe quarry was used as the common coarse aggregate, CEM I 52.5 N, Mid range plasticizer WRDA 90

The following materials were shipped to Japan, processed and returned to Wales:

- Granite from Glensanda Quarry, in Scotland from Aggregate Industries
- Basalt from Duntilland Quarry, in Scotland from Aggregate Industries
- Limestone from Taff's Well Quarry, in Wales from CEMEX
- Gritstone (Sandstone) from Gilfach Quarry, in Wales from CEMEX

All the stone types were able to be reprocessed by the Kemco V7 plant into similar sand gradations with improved shape

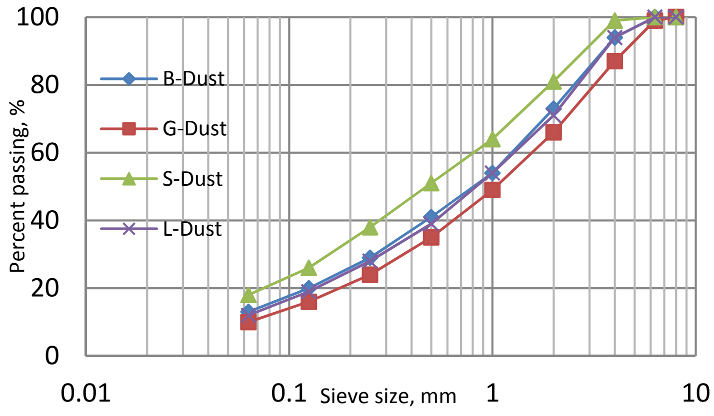
Characterisation tests

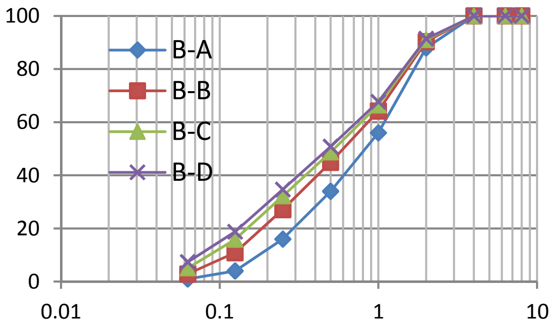


Manufactured sands

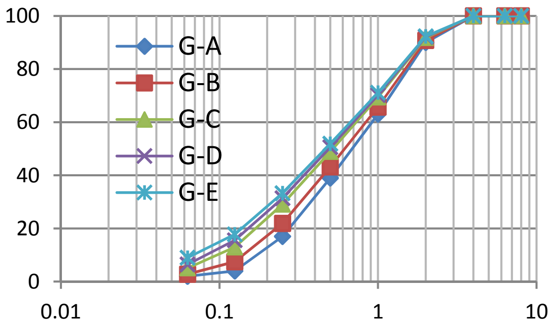
Manufactured sands from crusher dusts with at least 4 gradings for each quarry

- Basalt (B) – Duntilland Quarry, AI
- Granite (G) – Glensanda Quarry, AI
- Sandstone (S) – Gilfach Quarry, CEMEX
- Limestone (L) – Taff’s Well Quarry, CEMEX

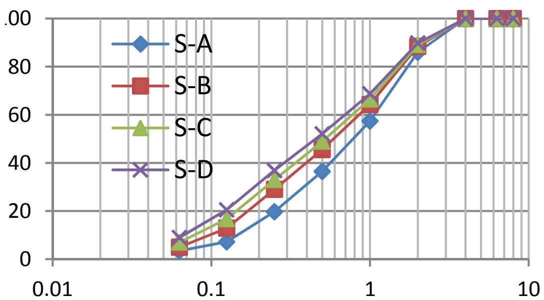




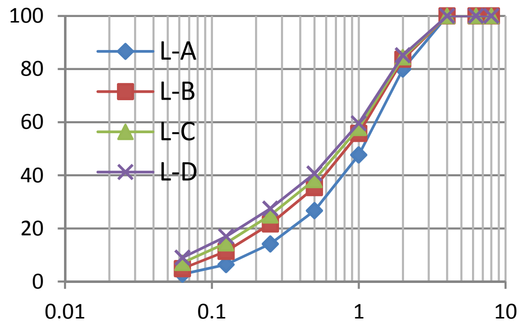
Basalt



Granite



Sandstone

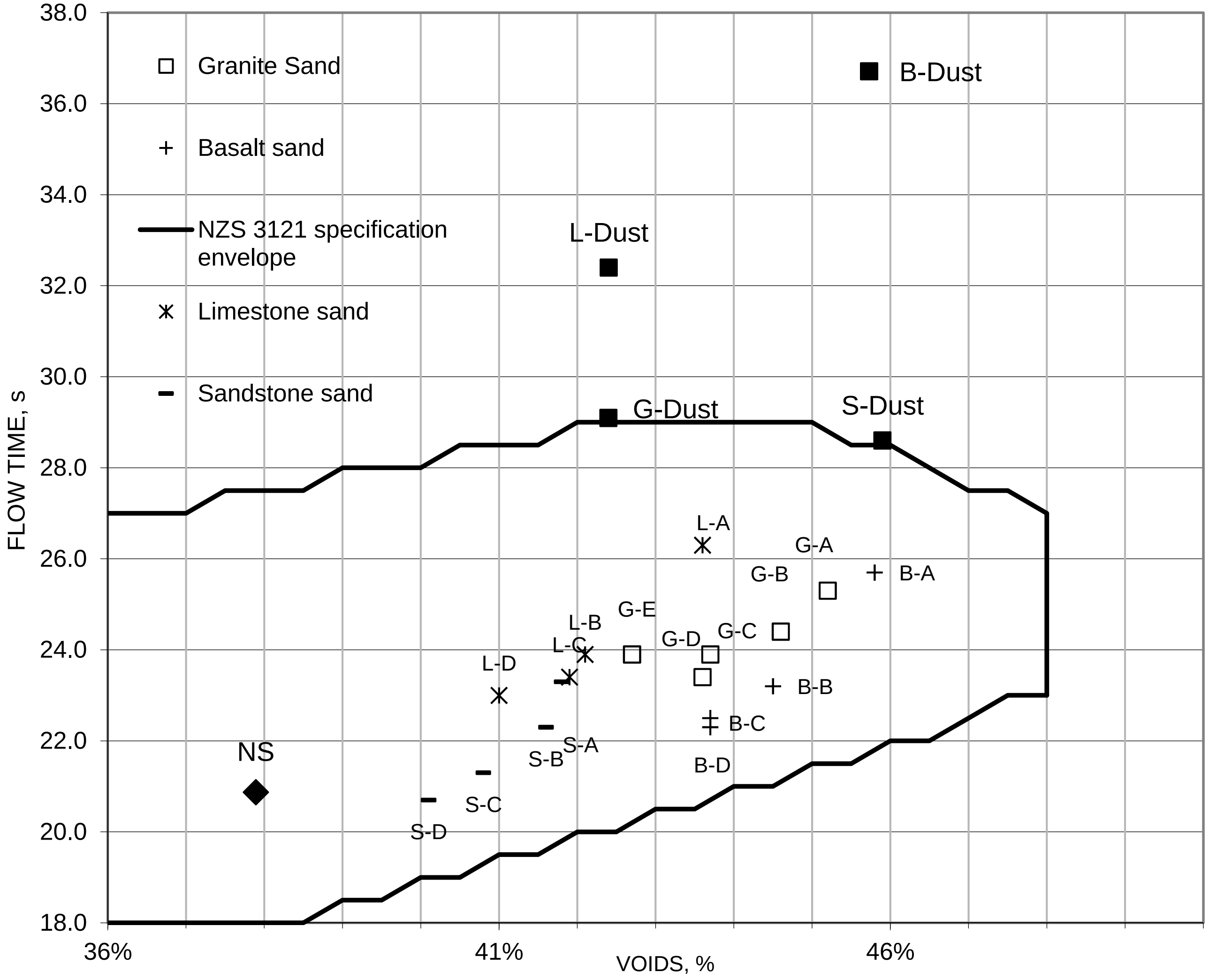


Limestone

Manufactured sand test results

- **New Zealand flow cone** – simple indirect test indicating shape, grading and surface texture

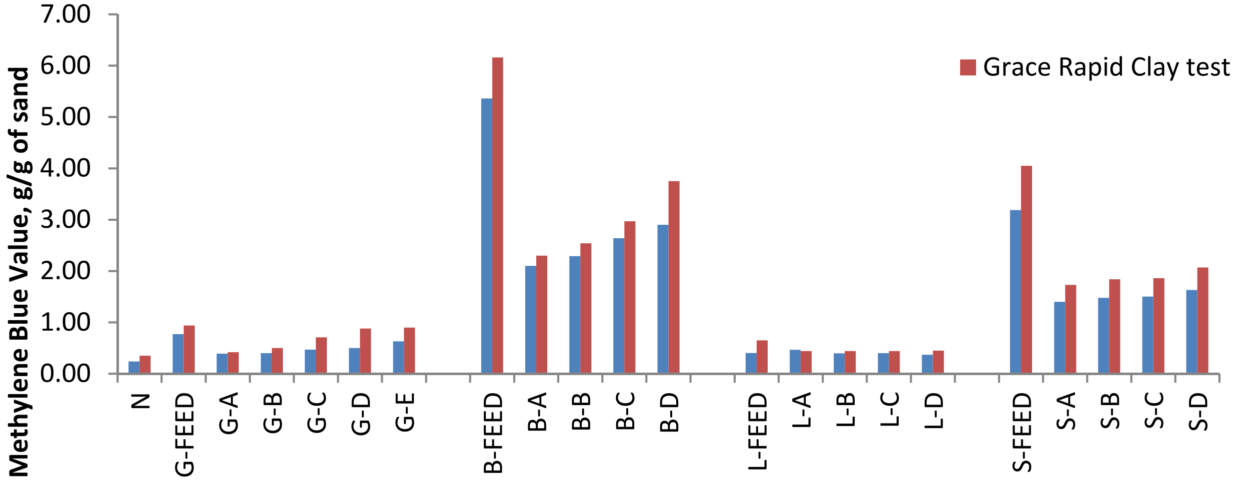
- All manufactured sands fit within the standard NZ envelope



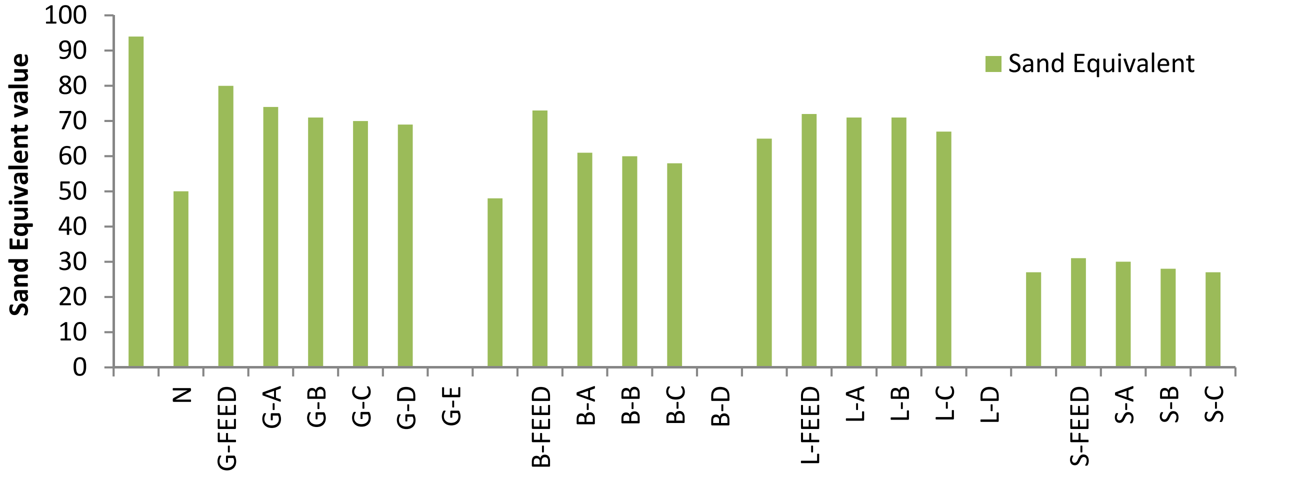
Manufactured sand test results

Methylene blue test (MBV) –
indication of potential presence of clays,
Grace's rapid clay test directly correlated with these results

MBV reduced in all manufactured sands if compared to feed material 0/4 mm fraction



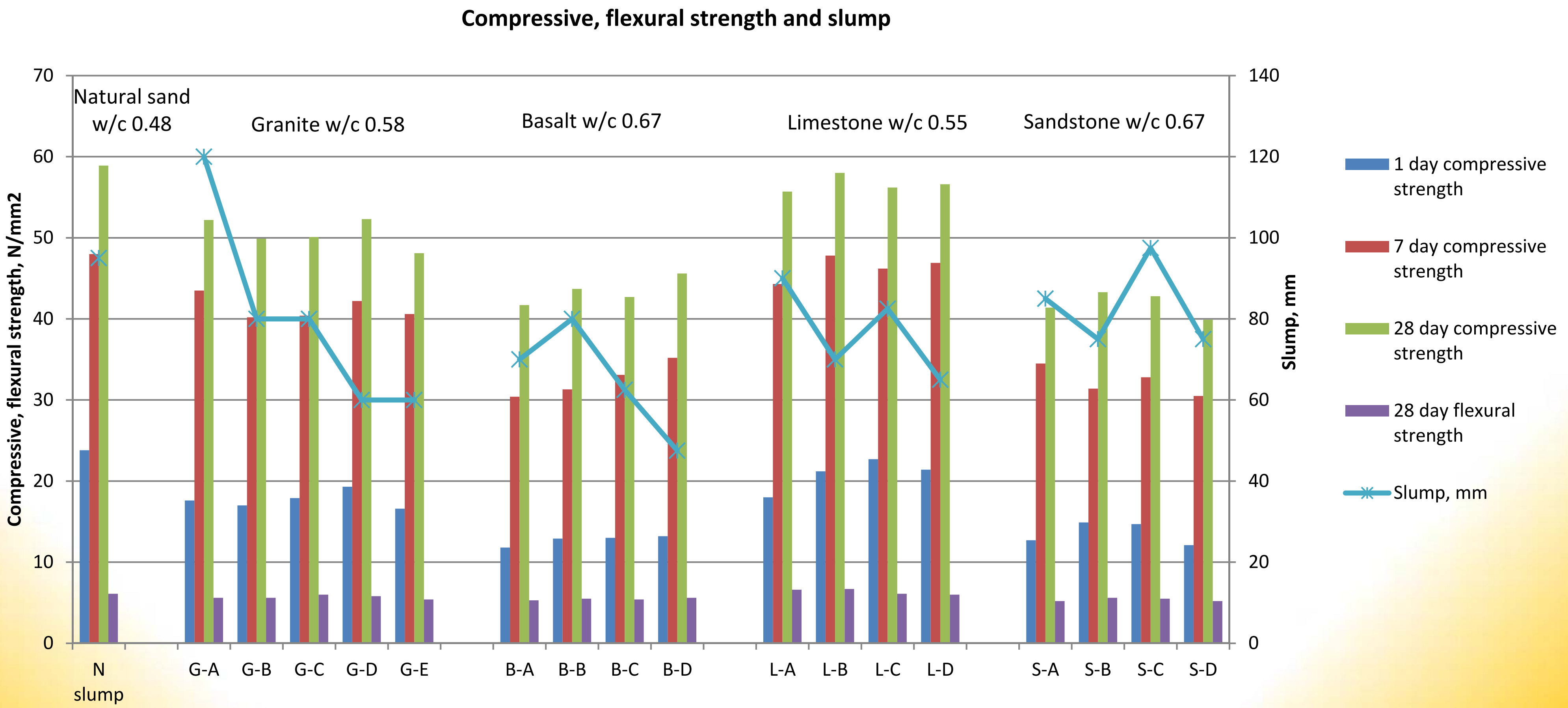
Sand Equivalent test (SE) -
Ratio of very fine particles to coarser particles. Can be used to identify potential deleterious particles in the sand, however, MBV is more reliable and correlates better with performance in concrete.



Concrete, Stage 1

- Stage 1: without plasticizer, aiming for S2 slump, fixed w/c ratio for particular quarry sands which provides S2 slump.

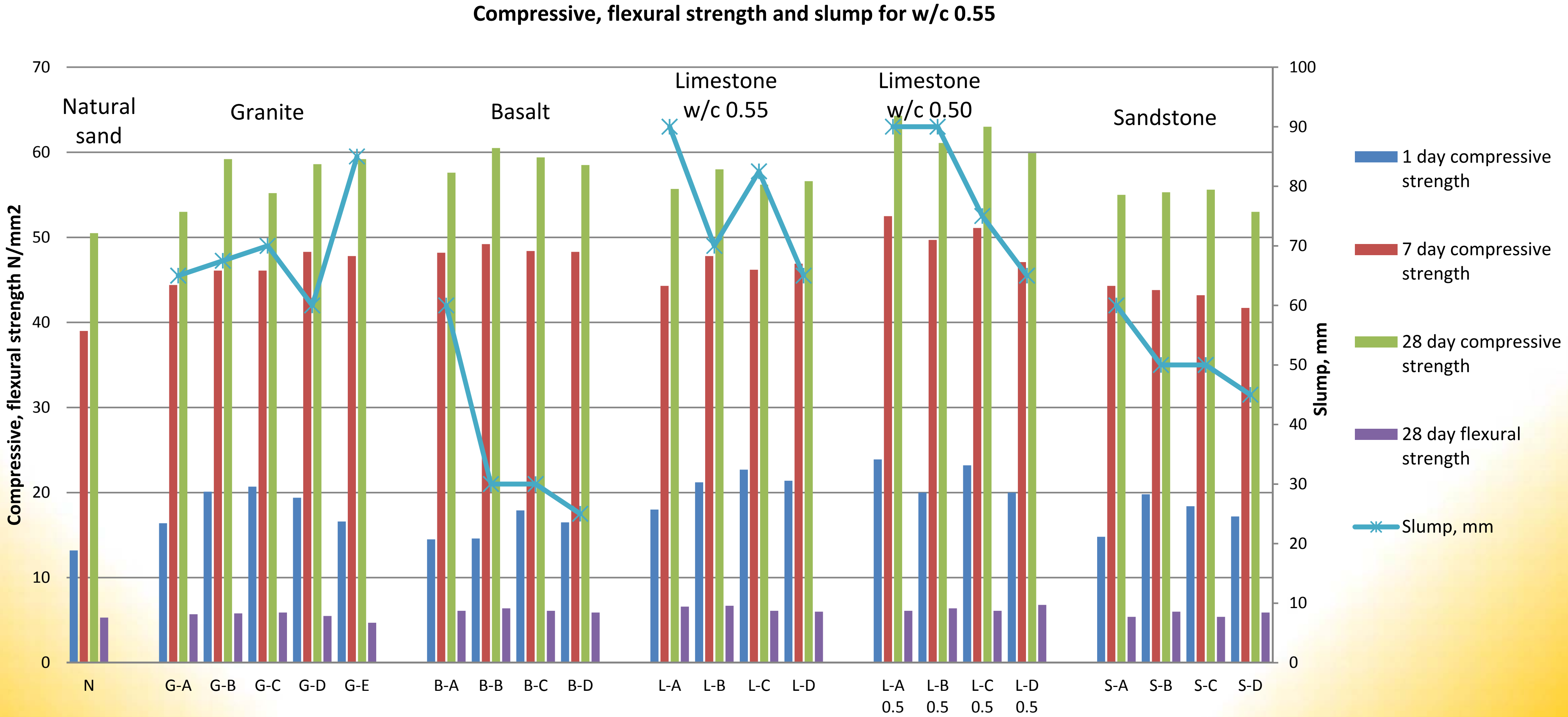
Cement	FA	CA	Water
350	753	1040	varies



Concrete, Stage 2

- Stage 2: Varying plasticizer dosage to achieve S2 slump, fixed w/c ratio at 0.55 for all sands.

Cement	FA	CA	Water	Plasticizer
350	753	1040	193	varies



Key Objectives

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- Secondary aim to refine gradations to reduce cement usage and to find new uses for rock filler in agriculture

  ONGOING

V7 sand can **COMPLETELY** replace natural sands in concrete!

Papers Written ex Cardiff University

Supervised by Diane Gardner & Prof Bob Lark

- **Manufactured Sand for a Low Carbon Era, by Martins Pilegis, presented at Dundee University's International Concrete Conference, July 2012**
- **Natural Sand Replacement in Concrete, presented at the Australian Construction Materials Industry Conference in September 2012**
- Design and Testing of Self-Compacting Concrete using Manufactured Sand, by Romans Volodskojs, BEng dissertation
- The Use of Manufactured Sand as a Replacement Material for Dredged Sand in Mortar, by Thomas A Kroh, MSc Dissertation
- Sustainable Extrudable Concrete, by Han Rui Chiew, MSc Dissertation

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The Economics

V7-60 Economics (60 tph throughput)

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Operating Costs

- Power = 6.7kwhr per tonne throughput
  @ 10p/kwhr = 67pence
- Wear parts and maint = £1.20 to £1.80 depending on material

Capital Costs

- Typical ~ £2m turnkey installation
- 60tph capacity = 200ktpa+
- 10 yr amortisation

Typical Opex ~ £2.00 /t throughput

Typical capital rec ~ £1.00 /t throughput

V7-60 Economics (60 tph throughput)

Sand Yields

- Range = 75% to 85%
- Typical = 80%
- Depends on feed
  - Crushing properties
  - Filler content

Replaces alternative reprocessing costs say £1.0/t

Premium all in fine aggregate ~ £2.0/t

(Assuming filler has no value and full capital recovery)

Filler (dry premium product)

- 15% to 30%
  - Granulate – drainage = £10/t
  - Road base = £12/t
  - Asphalt/block plants = £15/t
  - Agriculture = £20/t

Significant upside likely from filler

The economics compared

	Kayasand V7-60	Dredged Sand	Washed Pit Sand
Operating Cost per tonne sand produced	£2.00-£2.50[1]	£4.50 to £8.00[3]	£5.00 to £8.00[5]
Amortised Capital Cost per tonne	£1.0[1]	£3.0 to £5.0[2]	£2.0 to £3.0[4]
Environmental Impact	Low	High	High
Availability	High	Med	Med

1 Costs will vary depending on location and feed, these costs are typical of installations Kayasand has completed detailed evaluations for.
2 Allowance for resource consent, dredger, wharf facilities.
3 Will vary depending on the distance off shore for dredging.
4 Allowance for resource consents and capital investment – wash-plant , filter press etc.
5 Wash plant operating costs vary depending on water, waste costs, efficiency etc.

V7-60 Economics (60tph throughput)

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At the Quarry

- Marginal Cost of Crusher Dust
  - Say 0 – £5 /t of dust
  - £1.50 - £2.0 /t for re-processing
- Increased Sales Volumes
  - Say double the tonnage @ £10 /t
  - Say from 100,000t/y to 200,000t/y

Increased Quarry Profit

SAY:

Extra 100,000 tonnes @ £10/t – being £1,000,000pa

At a cost of 200,00 tonnes @ £2.0/t – being £400,000

At the Readymix Plant

- Increased Consistency (Reduced SD)
- Improved Concrete (Market Gain)
- Cement Savings
- Reduced Ad Mixtures & Mix Designs

Readymix Savings/Gains to be Quantified

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The Environment

The Japanese Experience

•Japan banned unnecessary dredging in 1991

• Kayasand now accounts for 40% of all of their manufactured sand

•While the introduction of Kayasand has been successfully implemented and the environment as well as the construction industry has benefited, ***regulatory change was necessary***

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Driving Change for Environmental Gain

- There is always resistance to change and construction is slower than most
  - Vested interests (dredging companies and divisions)
  - Apathy and lack of priority (bigger problems so park this)
  - Change upsets the balance of inter-related contracts (Company A buys sand from Company B and B buys Aggregate from A)
  - Very poor adopters of proven but novel technology
  - The environmental cost is not borne by them

"This sounds like a classic case of vested interests not willing to disrupt existing supply chains, compounded by a credit famine and uncertainty in the development sector!" Poul Kristensen, Chairman Natural England

Acknowledgements

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Aggregate Industries (Holcim)
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