Knight Piésold CONSULTING

Co-Disposal

~~Commingling~~

~~Paste Rock~~

DEFINITION

Mine waste streams are typically separated according to their particle size (due to their origin in the mining process)

Conventionally disposed of separately

Co-disposal combines waste streams in any of a variety of ways

CO-DISPOSAL WITH MINING PRODUCTS

- ***Tailings:*** disposed as a slurry
  - – high porosity
  - – water-filled voids.
- ***Waste Rock:***
  - – high porosity (>30%)
  - – air-filled voids “hopefully”

Co-disposal - tailings filling at least some of the voids in the coarse waste.

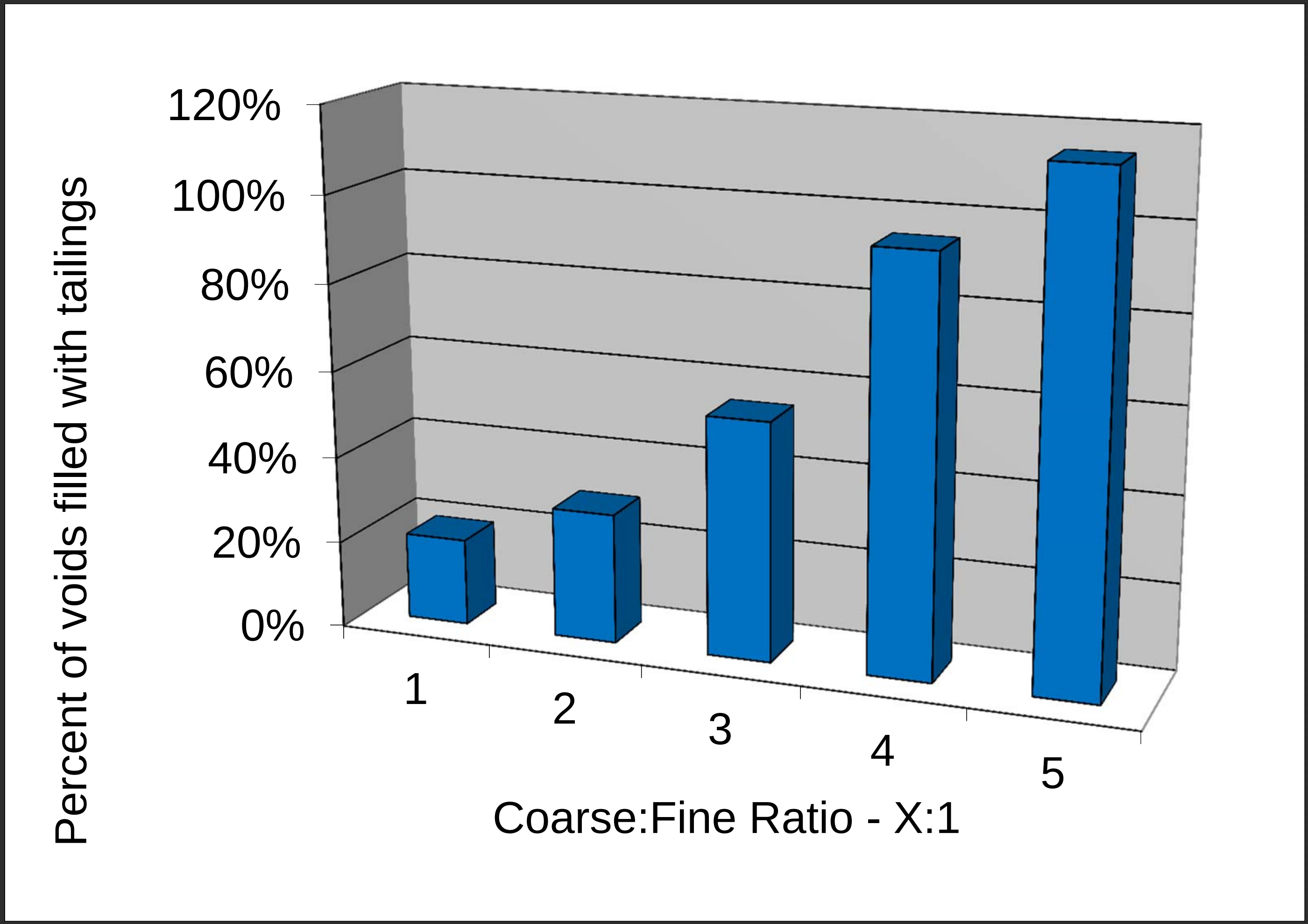
TYPICAL “RULE OF THUMB” POROSITIES

	Conv. Slurried Tailings	Compacted/ Filtered Tailings	Waste Rock
Particle SG	2.65	2.65	2.65
Dry Density (pcf)	65 – 90	90 – 110	90 – 110
Void Ratio	0.8 – 1.5	0.5 – 0.8	0.5 – 0.8
Porosity, pct	50 – 60	35 – 45	35 – 50

Porosity: ratio of volume of voids to total volume (*100%)
Void ratio: ratio of volume of voids to volume of solids

The intent is to “hide” tailings within the voids of the waste rock

EXAMPLE EFFECT OF C:F RATIO



DEGREES OF MIXING

Table 1. Methods of co-disposal.

Description
Homogeneous mixtures: waste rock and tailings are blended to form a homogeneous mass (placement method unknown)
Pumped co-disposal: coarse and fine materials are pumped to impoundments for disposal (segregation occurs)
Layered co-mingling: alternating layers of waste rock and tailings
Waste rock is added to a tailings impoundment
Tailings are added to a waste rock dump
Waste rock and tailings are disposed in the same depression
Separate disposal: waste rock in dumps and tailings in impoundments

PERFECTLY BLENDED, HOMOGENEOUS MIXTURES OF TAILINGS AND WASTE ROCK: PASTE ROCK

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"Paste rock"

Many mining companies have found that the "mine waste" issue is growing and won't go away. In the previous "Tailings Tips" article (CMJ August 2007), Golder Associates' Don Welch observed that simply finding an acceptable place to put tailings and waste rock is becoming a challenge. Then there are the long-term liability issues associated with conventional tailings facilities, and the question of who will be around to maintain these structures a century or so from now.

Finding a better way to store tailings so that the metals, acids and other hazards they may contain stay isolated from the rest of the environment, goes a long way to reducing costs and liabilities.

One possible answer to these challenges is to dispose

Co-author Ward Wilson stands on a paste rock deposition, supported by the rock matrix under the paste.

BLENDED, RELATIVELY HOMOGENEOUS MIXTURES OF TAILINGS AND WASTE ROCK

- Tailings and mine waste are mixed relatively homogeneously
- Tailings essentially fill “all” the voids between waste rock particles
- Waste rock has predominantly rock-to-rock contact

Blended Tailings/Waste Rock

Benefits/Goals:

- Reduced footprint
- Shear strength like waste rock
- Permeability like tailings
- Low oxygen diffusion rates
- Greatly(?) reduced ARD potential
- Improved permitting timeline
- Better public acceptance
- Improved closure opportunities…

Governing equations for ARD

The common chemical equations associated with ARD are shown below:

$$2\,FeS_2 + 7\,O_2 + 2\,H_2O \Leftrightarrow 2\,Fe_2{+} + 4\,SO_4^{2-} + 4\,H^+ \quad (1)$$

$$2\,Fe^{2+} + 1/2\,O_2 + 2\,H^+ \Leftrightarrow \underline{2\,Fe^{3+}} + H_2O \quad (2)$$

$$2\,Fe^{3+} + 6\,H_2O \Leftrightarrow 2\,Fe(OH)_3 + 6\,H^+ \quad (3)$$

$$FeS_2 + 14\,Fe^{3+} + 8\,H_2O \Leftrightarrow 15\,Fe^{2+} + 2\,SO_4^{2-} + 16\,H^+ \quad (4)$$

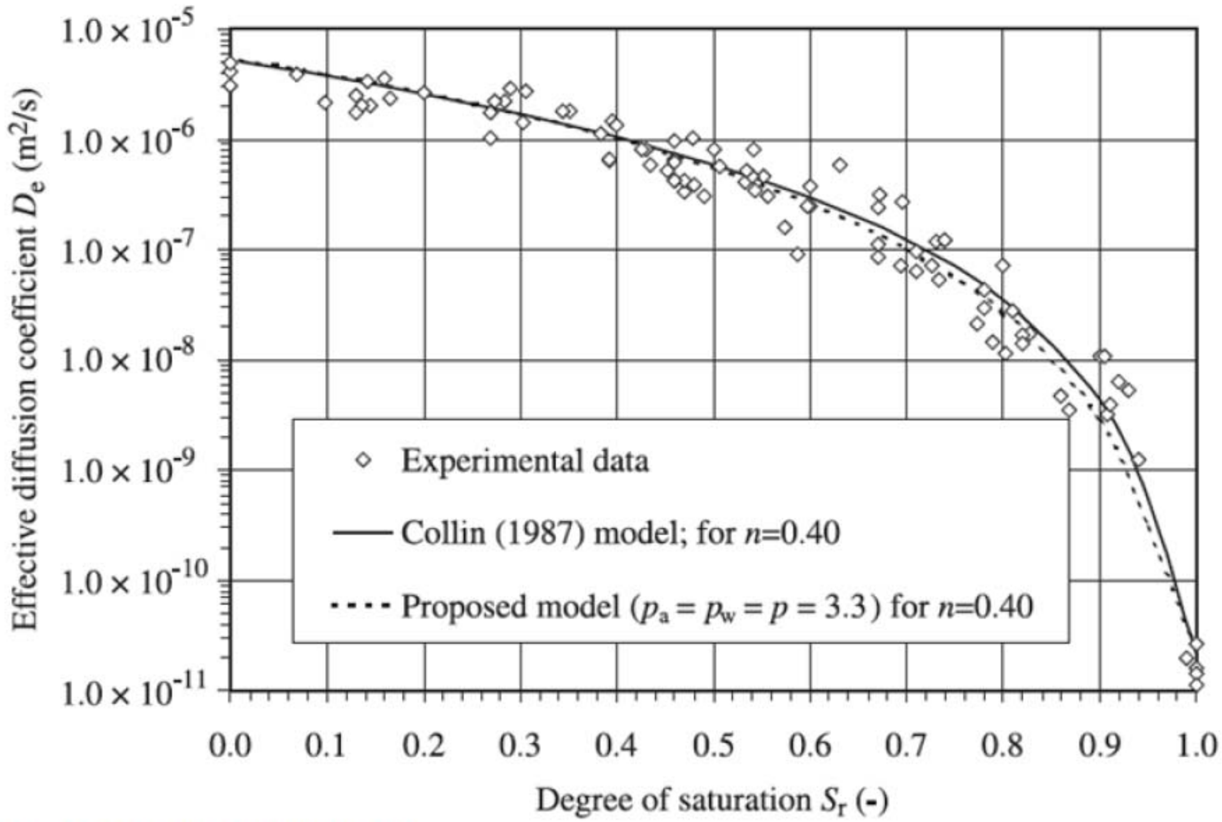
There is a similar reaction for carbonate rocks:

$$CaCO_3 + 2\,H^+ + SO_4^{2-} \Leftrightarrow CaSO_4 + H_2O + CO_2 \quad (5)$$

Keep the Fe from going ferric

Above about 85% Saturation: Oxygen Diffusion Essentially Eliminated

Fig. 2. Comparison between diffusion coefficient values measured on different materials (soils, tailings, and geosynthetic clay liners; data taken from Aubertin et al. 1999, 2000*b*; and Aachib et al. 2002[4]) at various S_r, with predicted values obtained with the model of Collin (1987) and the proposed eq. [16].



From: Mbonimpa et al., 2003, Figure 2.

Keeping the air out will keep the Fe from going ferric

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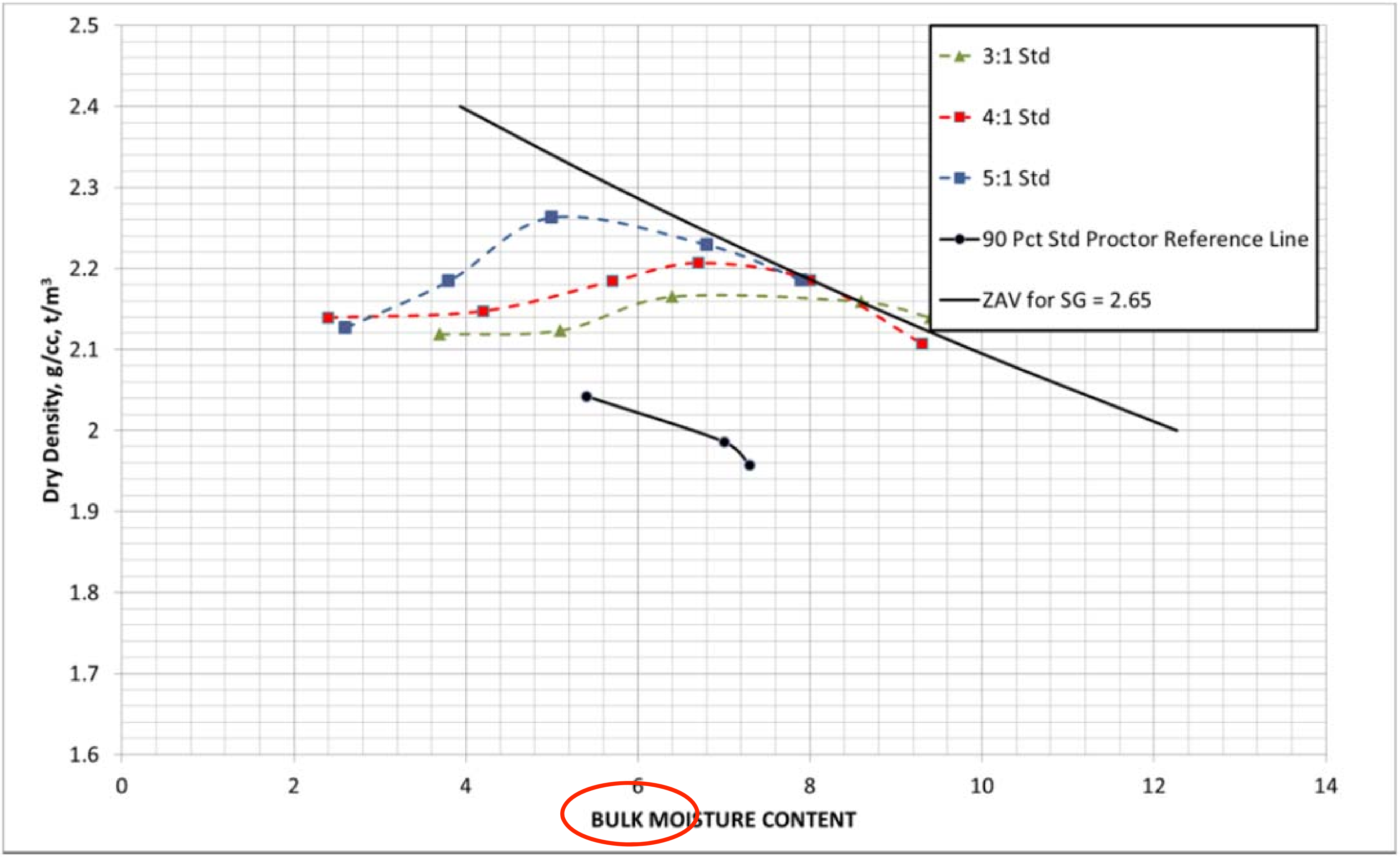
Proxy
waste
rock

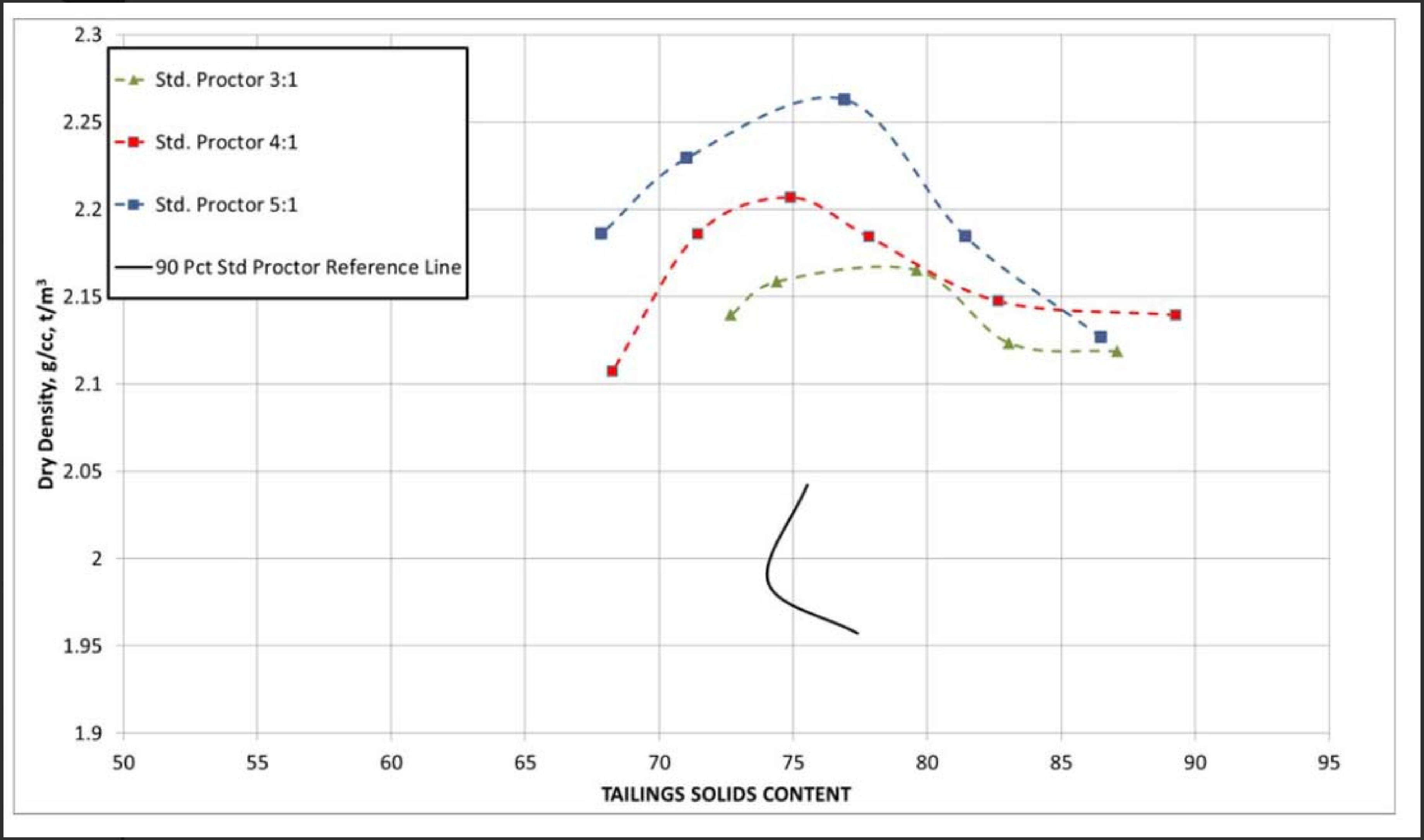
LA Abrasion Machine

11 Secret Herbs and Spices

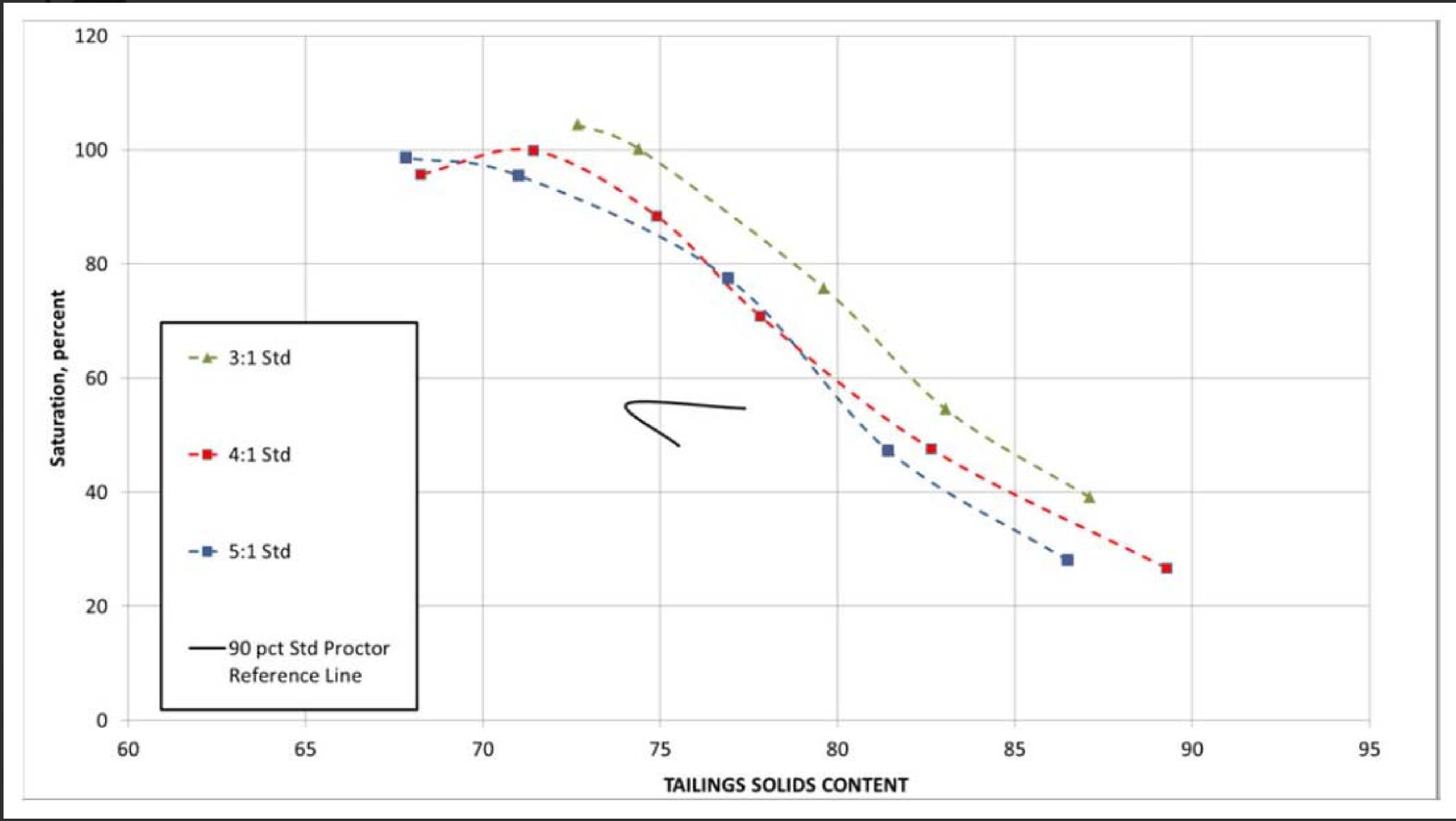
PROCTOR TEST RESULTS



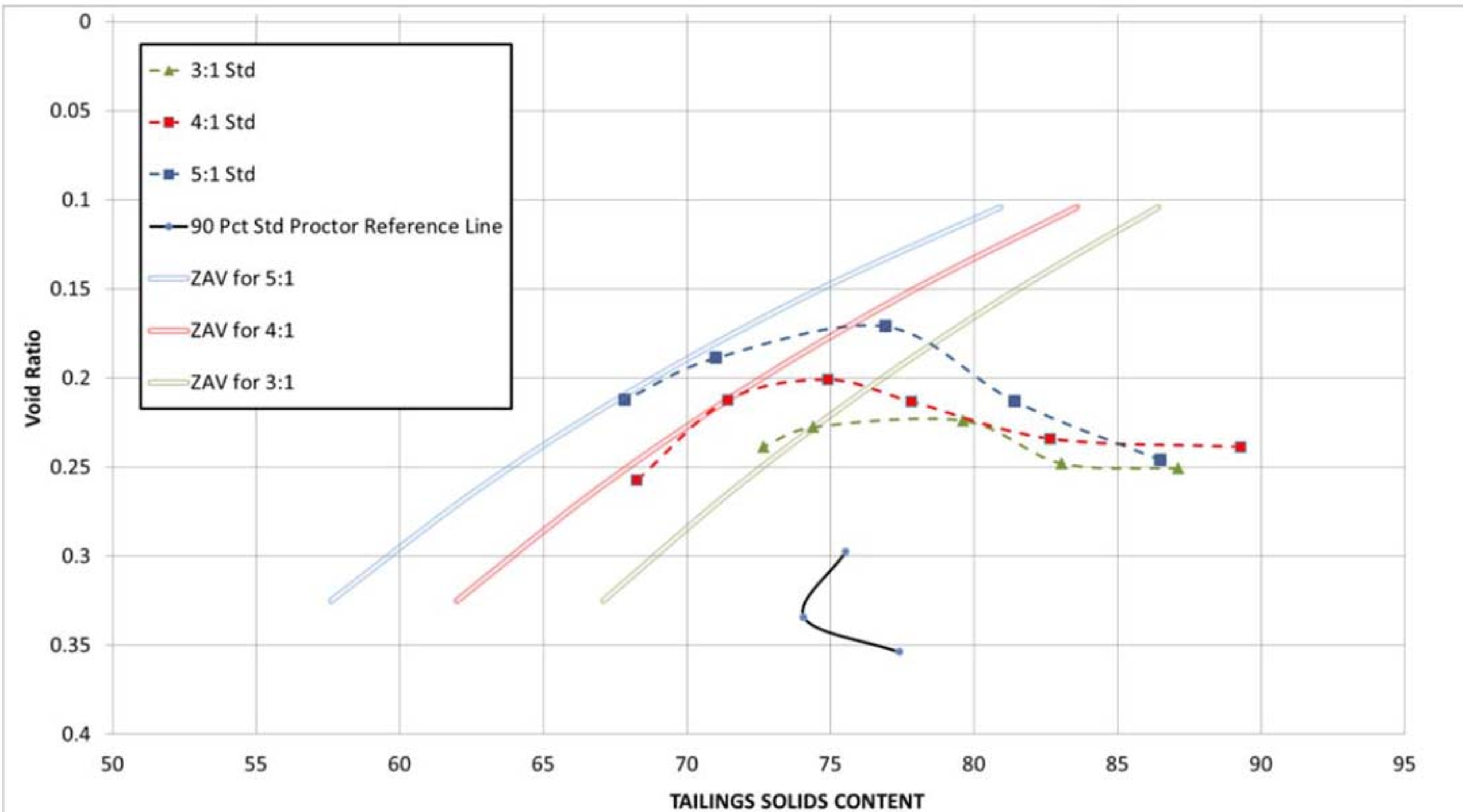
Proctor in terms of solids content



At least in these tests:
a lower solids content is better



Zero Air Voids



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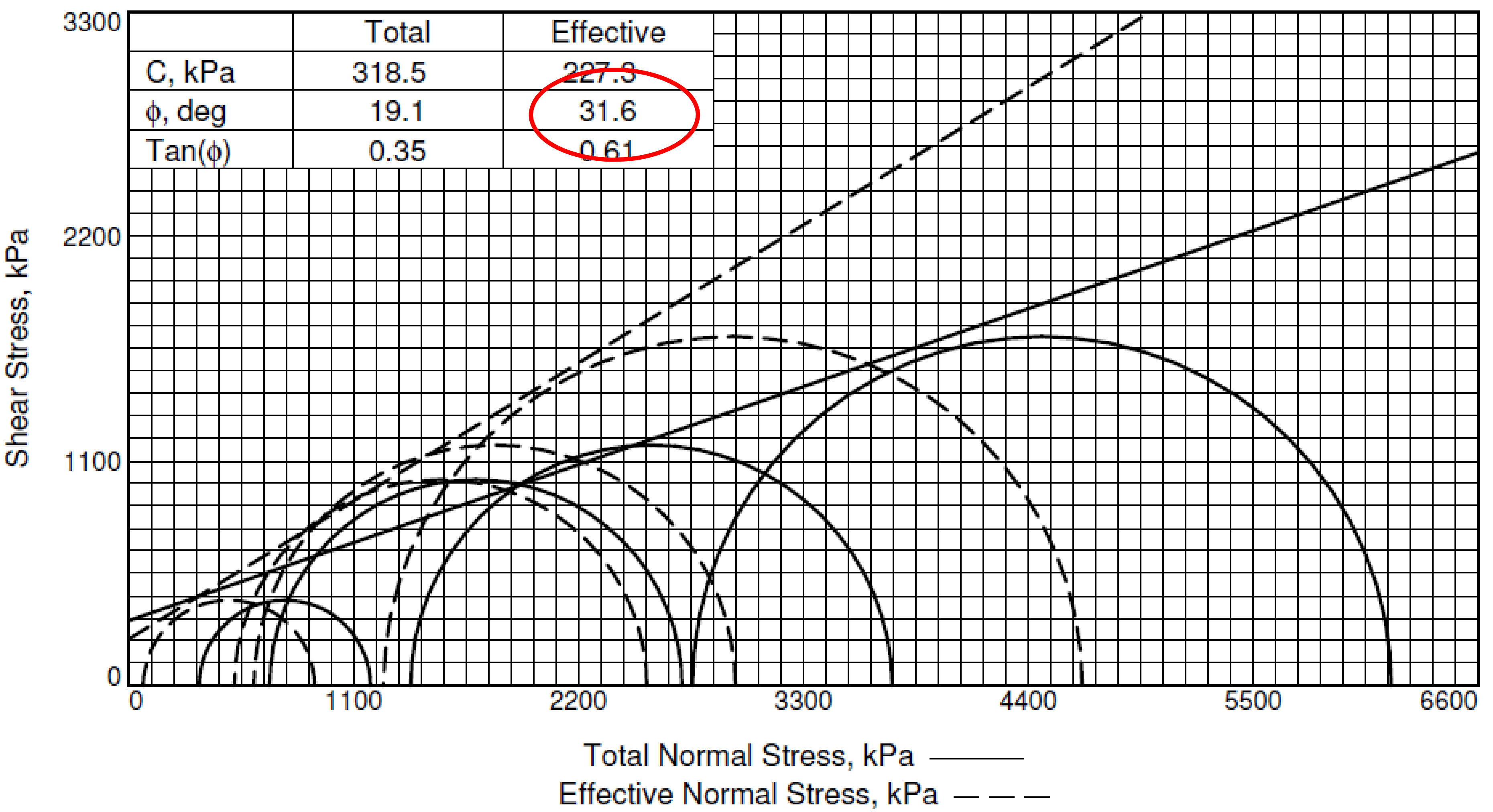
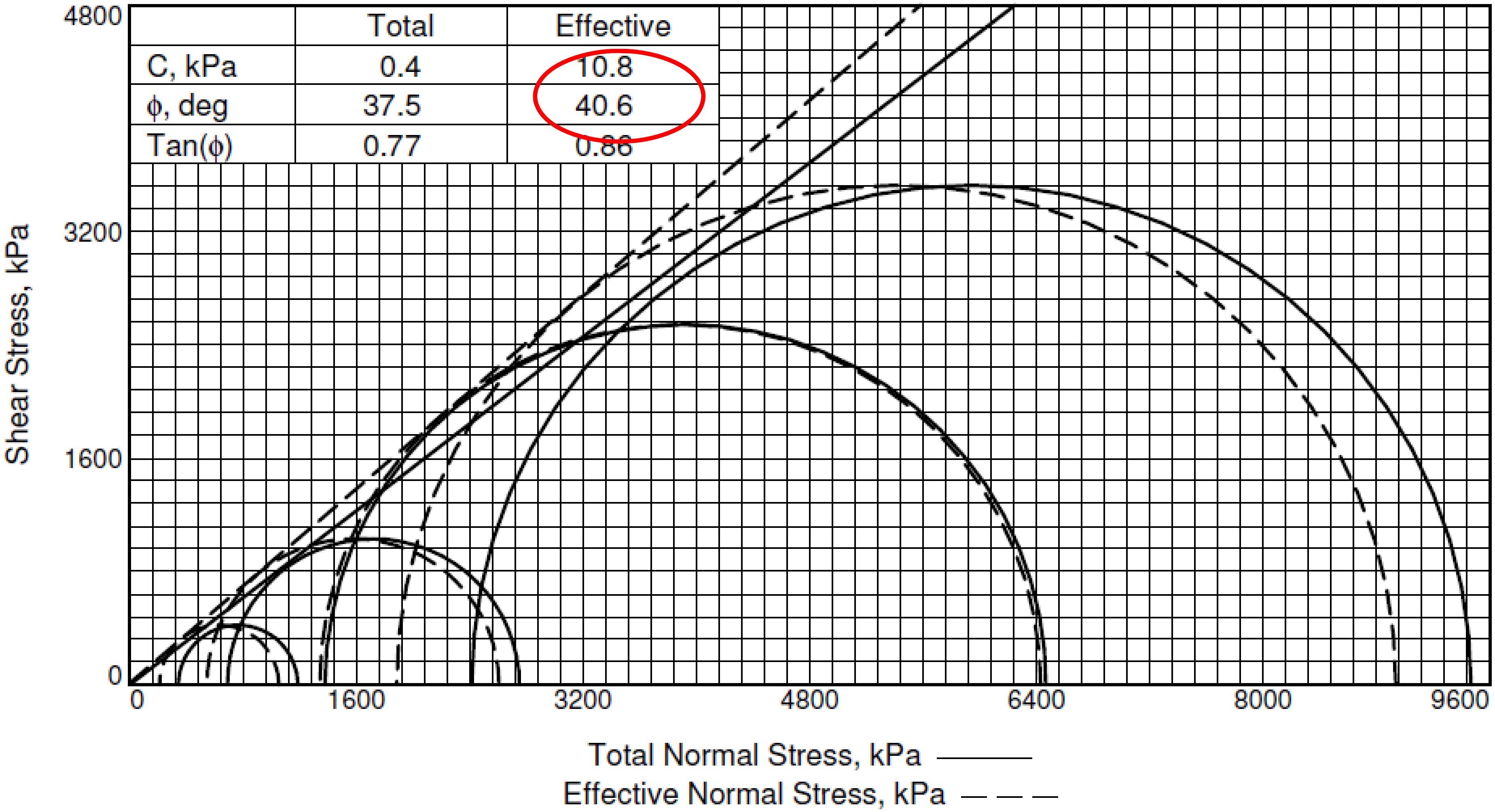
6-inch
dia.
Triaxial
shear
testing

3:1 Blend



	Total	Effective
C, kPa	318.5	227.3
ϕ, deg	19.1	31.6
Tan(ϕ)	0.35	0.61

4:1 Blend



	Total	Effective
C, kPa	0.4	10.8
ϕ, deg	37.5	40.6
Tan(ϕ)	0.77	0.86

Co-disposed Tailings

Challenges:

- Maintaining +/- proper mixing ratios
- Defining proper mixing ratios
- Developing design properties (hydraulic, shear strength, etc.)
- Mixing method
- Placement/spreading method

Co-disposed Tailings

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Material Mixing: Where to from Here?

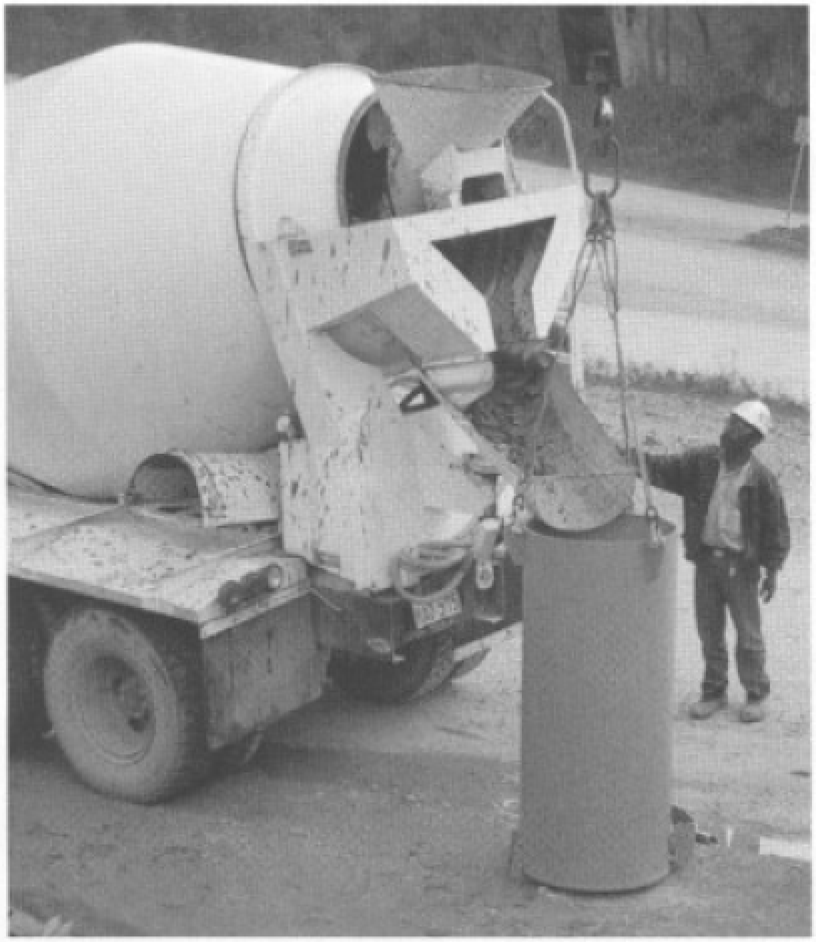


Figure 2 Concrete transit mixer truck and skip

36 Geotechnical News, September 2005

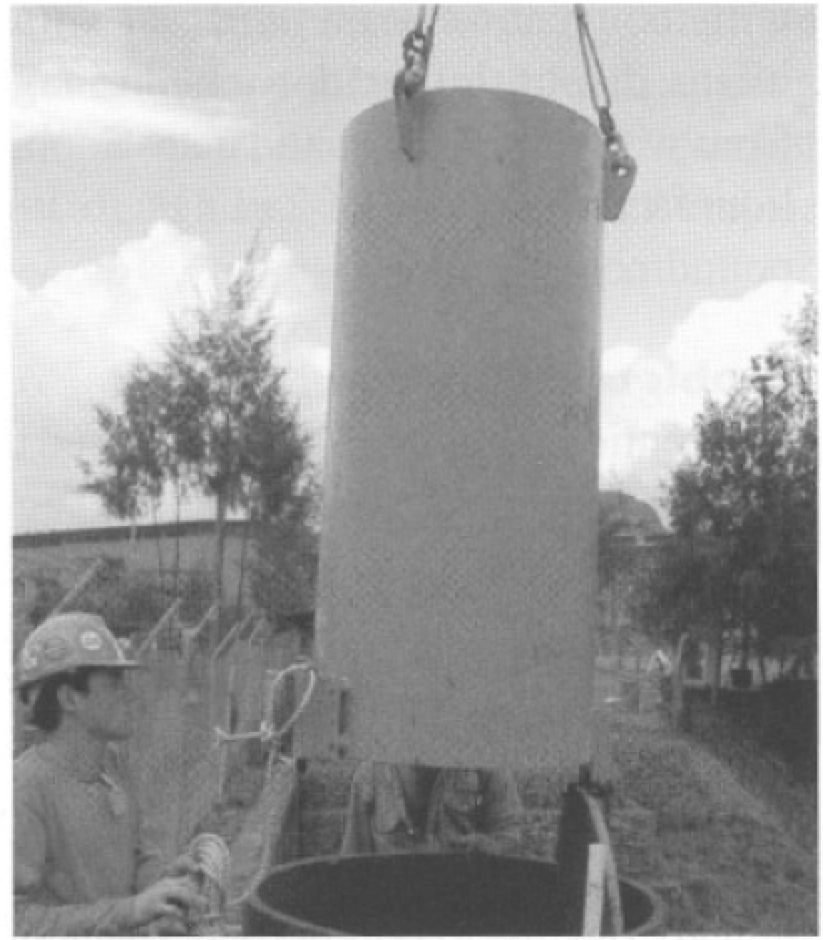
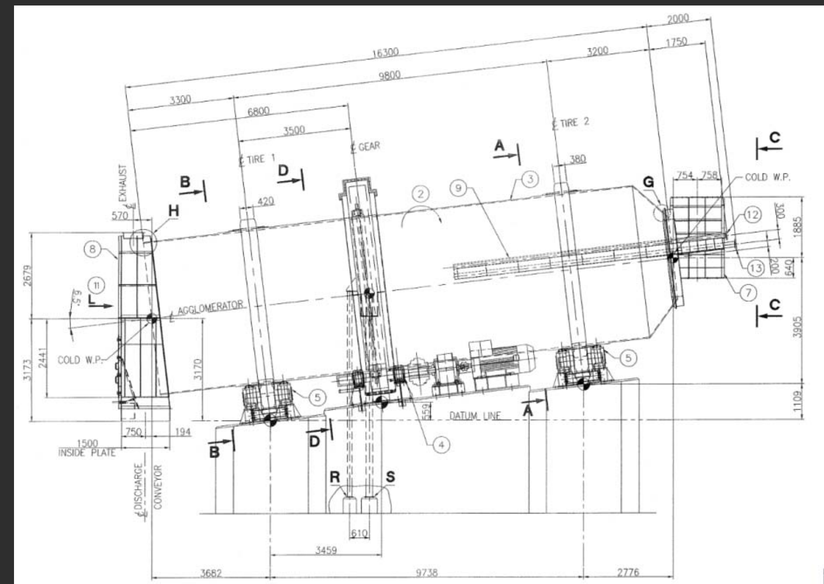


Figure 3. Skip during column loading

No, no, bigger, BIGGER!

SECRECTS TO MIXING???



Agglomerator

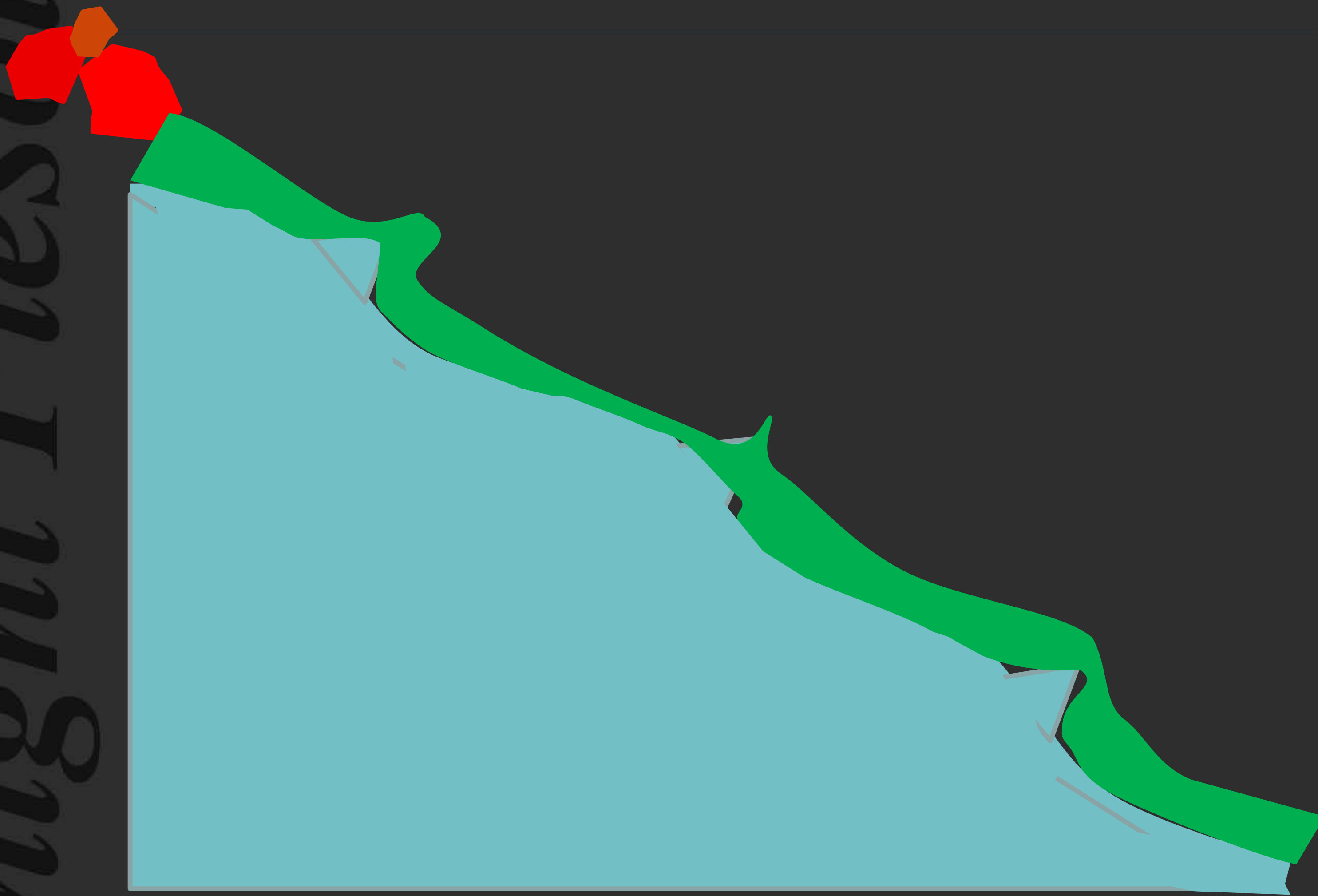
•Continuous concrete mixer
•PUG mill
•Agglomerator

They all want very dilute slurry and small sized rock particles

Flow-through Ball Mill

Material Mixing: The Concept

Laboratory Mixing: The Concept



"The water slide from hell"


exel
09/09/2011

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Blending: The Next Step?

FIELD TRIALS

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END