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CETANZ

**Solid Density for Bituminous Granular
Materials – What is Right?**

August 2025

COOL TITLE NICK, WHAT'S THE ISSUE?

Solid Density is needed for:

- MDD voids lines
- Degree of Saturation

Traditionally, we haven't always done MDD or SD

Assumed or calculated SD for foamed bitumen

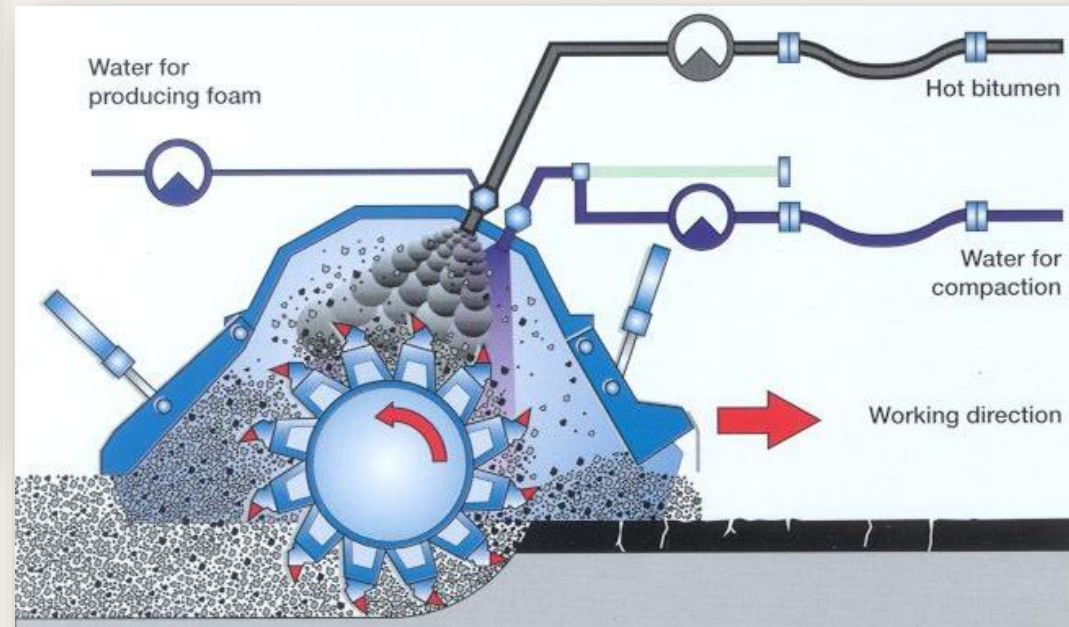
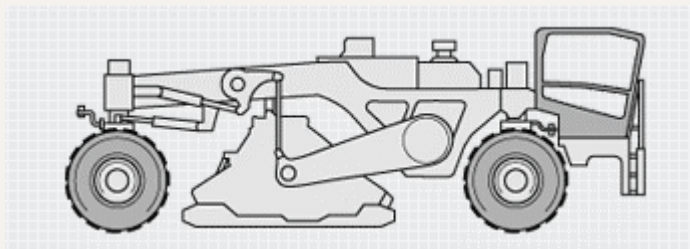
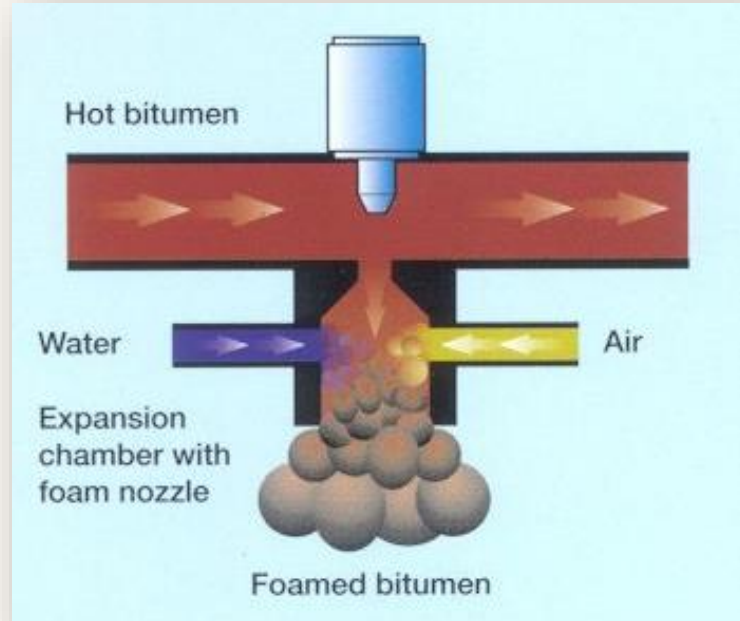
Not every aggregate has a quarry SD done – so the calculation can't be done unless we go to the lab

Guessing!!!

More rigor around QA means needing to test foamed bitumen SD

Tests were odd...

WHAT IS FOAMED BITUMEN RECYCLING?



WHAT IS FOAMED BITUMEN?

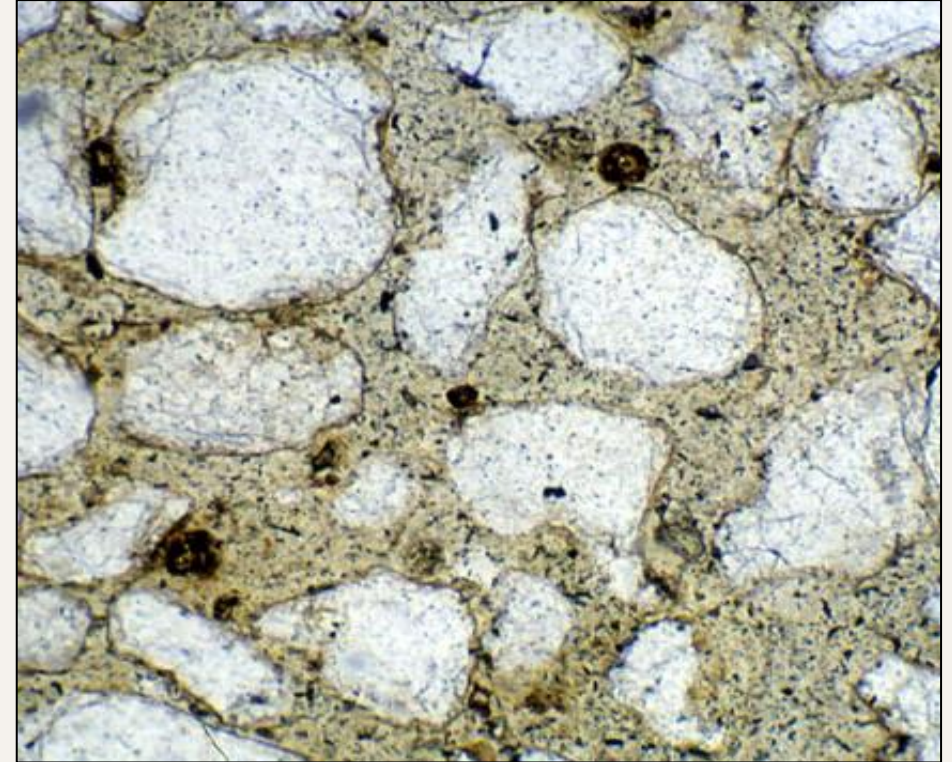
NOT granular

NOT asphalt

Fine particles are coated in bitumen

Large particles are not

- NZS 4407 3.7.1 & 3.72 for granular
- ASTM C127 & 128 (and D2041) for asphalt
- Nothing for Foamed Bitumen



WHERE DID THIS START?



Voids too high for MDD

So voids lines are in the wrong place

Why? SD incorrect!!! Too low

WHERE DID THIS START?

Test Results		
Solid Density (t/m³) 2.37 2.37t/m³		
Test Methods	Notes	
Solid Density:	NZS4407 : 2015 Test 3.7.1	Sample descriptions are not covered by IANZ Accreditation

Test Results	
	
Theoretical Maximum Specific Gravity (ASTM D2041/D2041M - 19)	
Container Type:	Bowl
Procedure	9.5.1 (2 Samples)
Mass of sample	2697.9 g
Maximum Specific Gravity	2.424 G _{mm}
Note:	Test carried out on uncoated foam bitumen stabilised basecourse sample

Same material – different tests...and waaaay too low

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IMPLICATIONS ON DOS

- Solid Density too high = DOS too low
- Solid Density too low = DOS too high
- Risk of sealing too wet or having to wait too long to seal when the surface is ready



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WHAT DO WE DO? WHAT DID WE DO?

NZTA T28: 2024

Test Method for the Determination of the Dry Density and Water Content Relationship of Aggregate

Compare different ways of doing it:

- NZTA T28: 2024 (MDD with modified SD test)
- MTSG – using ASTM
- NZS 4407 – 3.7.1 (modified method)
 - 3.7.2 not a problem as larger stone has no bitumen
- Whole sample (4407 – 3.7.1 standard method)
- Calculate based on natural SD + bitumen density / content
 - This is how we previously assessed FB SD



NZS 4407:2015

New Zealand Standard

Methods of sampling and testing road aggregates

Superseding all parts of NZS 4407:1991

- T28 (NZS 4407 3.7.1 & 3.7.2) T28 modifies to have coarse fraction retained on 26.5mm for T28 – not 19.0mm as per 4407 – 3.7.1)
 - Grading & proportioned by sample fraction
- NZS 4407 – 3.7.1 (minor fraction – passing 19mm) **modified** with 15 minute vacuum prior to test
- Whole sample – 3.7.1 fractions not split - put it under suction prior to testing

FOAMED BITUMEN SPECIFIC GRAVITY CORRECTION	
Project / Job name:	
Design Bitumen Application:	3.0 %
Parent Material Geology:	2.76 t/m ³
Bitumen Application $\times$ $\left(\frac{\text{Aggregate Specific Density}}{\text{Bitumen Density}} \right) =$ Volume of Bitumen (%)	
Volume of Bitumen =	8.039 %
$\left(\frac{\text{Bitumen Density} \times \text{Volume of Bitumen}}{100} \right) + \left(\frac{\text{Aggregate Specific Density} \times \text{Volume of Aggregate}}{100} \right)$	
Corrected Specific Gravity =	2.62 t/m ³

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WHAT HAPPENDED?

Compare different ways of doing it:

T28 looked pretty good – but issues with SD method with a bituminous material

During material dryback at 60°C on NZS 4407 – 3.7.1 sample (fine fraction – passing 19.0mm):

- bitumen encapsulated / clumped up the fine material – stopping water getting through
- Bitumen sticking to tray etc. caused issues by loss of mass (bitumen and fines etc) from material.

So needed to modify this method further...



WHAT ARE WE DOING NOW?

T28

For 3.7.1 – fine fraction:

- Start from the wettest point – i.e. soak immediately for 24hrs
- Empty everything into tray including water – wash out container to ensure everything removed.
- Dryback at up to 108°C – no longer concerned over bitumen softening

More consistent results.

This from Stevensons (say different quarry) but used to assess the test method

WHAT ARE WE DOING NOW?

Test Results			
Solid Density Method	FBS Sample	Natural Aggregate	Notes
NZS 4407:2015 test 3.7.1 (Aggs Pync)	2.639 t/m ³	2.749 t/m ³	M2 Dry mass calculated using water content of sub sample. 1*
	2.635 t/m ³	2.759 t/m ³	M2 Oven Dried post test. 2*
NZS 4407:2015 test 3.7.2 (Aggs Imers)	2.754 t/m ³	2.750 t/m ³	M2 Oven Dried post test. 3*
NZTA-T28:2024 Combined Solid density	2.640 t/m ³	2.760 t/m ³	Calculated from M2 oven dried post test results.
% Passing 26.5mm Sieve.	96%	96%	From: AL12093/1 PSD Report

Notes: Foam Bitumen sample foamed by WSP Auckland Lab. 1* & 2* - NZS 4407:2015 test 3.7.1 (Aggs Pync) fraction passing the 26.5mm sieve tested, 3* - NZS 4407:2015 test 3.7.2 (Aggs Imers) fraction retained on the 26.5mm sieve tested. NZS 4407:2015 test 3.7.1 (Aggs Pync) & NZS 4407:2015 test 3.7.2 (Aggs Imers) departure from method, sample oven dried post testing / soaking for M2 Oven dried post tests results. 1* - M2 Dry mass calculated using the water content of sub sample; a subsample of material passing the 26.5mm sieve was tested for water content, the water content was used to calculate the apparent dry mass of aggregate in the pycnometer (M2) pre testing.

If we are within approx. 50kg/m³ the DOS is not greatly affected.

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Project / Job name:			
Design Bitumen Application:	3.0	%	
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Bitumen Application $\times \left(\frac{\text{Aggregate Specific Density}}{\text{Bitumen Density}} \right) = \text{Volume of Bitumen (\%)} $			
Volume of Bitumen =	8.039	%	
$\left(\text{Bitumen Density} \times \text{Volume of Bitumen} / 100 \right) + \left(\text{Aggregate Specific Density} \times \text{Volume of Aggregate} / 100 \right)$			
Corrected Specific Gravity =	2.62	t/m ³	

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CONCLUSION

Use modified T28 – i.e. start soaking fine fraction immediately (for 24-hours) to remove concern over bitumen clumping / softening during dryback.

If we are within approx. 50kg/m^3 the DOS is not greatly affected.

With IDC's the Degree of Saturation is going to be very important – need to have the Solid Density right.



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Thank you

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