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AQA/IOQ Conference 2026
Aggregate of the Future

July 2026

Introduction

- Our roads are getting busier requiring ever increasing robust pavements
- Aggregates aren't created equal and one size does not fit all.
- Consideration to be given to aggregate characteristics during the design process.
- Binder selection considerations based on aggregate properties.

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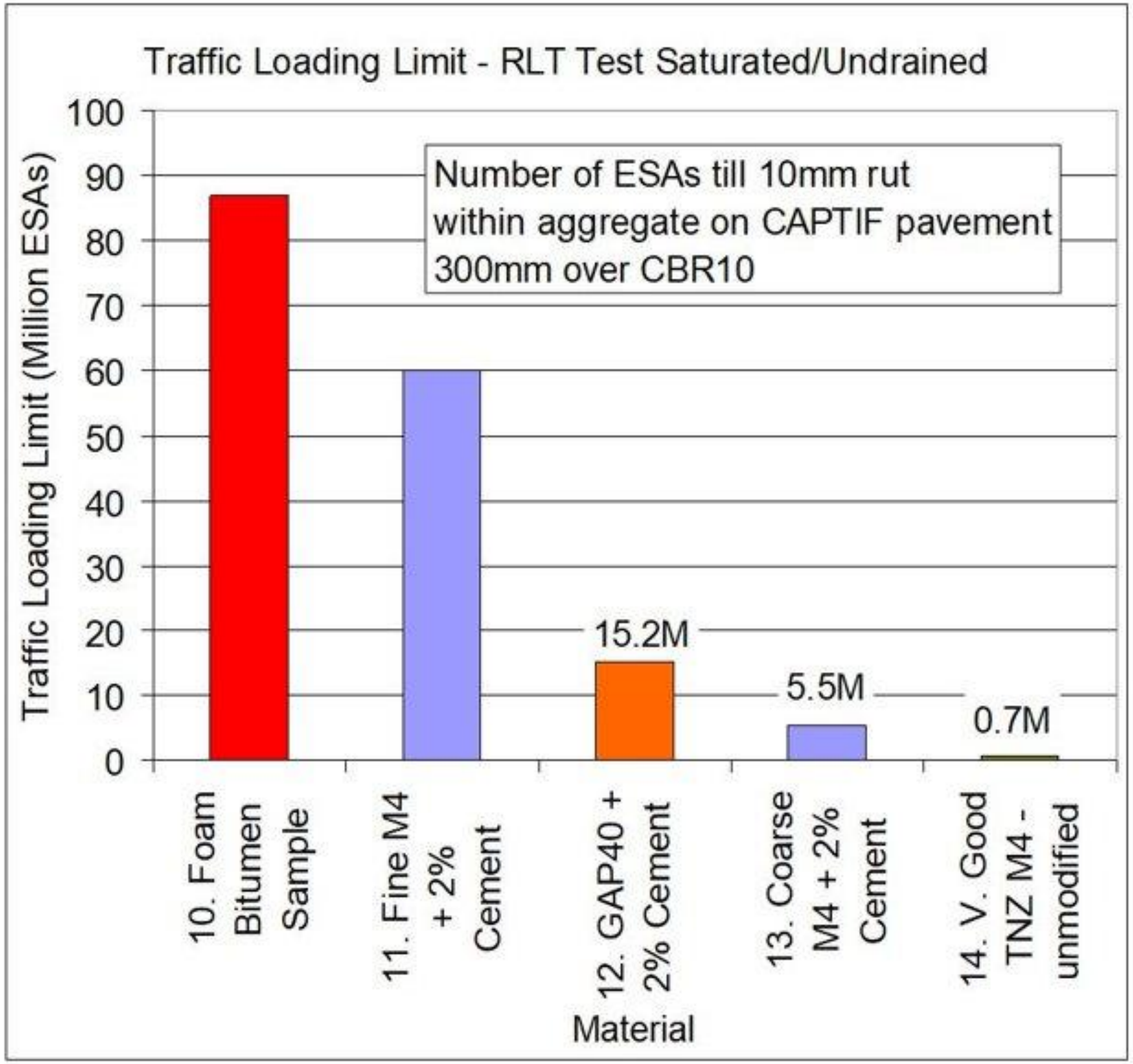
Stabilisation State - Unmodified, Modified or Bound

State	Binder	Characteristics
Unmodified	None	No tensile capability
Modified	<1.5% binder lime/cement	No significant tensile capacity, binder to mitigate plasticity
Lightly bound	Usually less than <2.0% binder	Tensile capability, not strong enough to propagate cracking
Bound	Cementitious binders >4.0%	Significant tensile capability, thermal shrinkage and fatigue crack risk
Nirvana	Optimised binder selection	Pavement layer achieves all four states

Reducing moisture sensitivity

Rut resistance is stellar but also need to manage:

- Durability
- Crack risk – too much active filler risk of shrinkage / block / fatigue cracking



Source: NZTA CAPTIF research

NZTA M/4 :2024 Specification for Basecourse Aggregate

Introduced:

- Classes of aggregate.
- The concept of loading in relation to performance.
- The concept of aggregate risk (rightly or wrongly)

Table 1: Aggregate Classes

Aggregate Class	Duty
Class 1	Very Heavy
Class 2	Heavy
Class 3	Medium
Class 4	Light

Table 1: Aggregate Classes

Aggregate Class	Duty	Loading (ESA)
Class 1	Very Heavy	Less than 10^7
Class 2	Heavy	Less than 5×10^6
Class 3	Medium	Less than 10^6
Class 4	Light	Less than 10^5

Source: NZTA M/4 Specification for M/4 Basecourse aggregate & the notes

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Modification of NZTA M/4 Compliant Basecourse Aggregates – Proposed Interim Guidance

- Developed jointly by AQA and CCNZ
- Table has been proposed to NZTA as interim guidance until the rehab guide is published.
- Developed to address supply issues with NZTA M/4 Class 1 aggregate being geographically limited.
- Address aggregate efficiency requirements

25-year design traffic volume (ESA's)	< 10^6	< $5x10^6$	Between $5x10^6$ & $1x10^7$	Between $1x10^7$ & $5x10^7$	> $5x10^7$
Typical Project Reliability	80%	80% - 90%	90% - 95%	95% - 97.5%	97.5%
NZTA M/4 Class 1	Unbound	Unbound	Unbound	FBS MA	Refer to NZTA guide
NZTA M/4 Class 2	Unbound	Unbound	MA FBS / BBB	FBS	Refer to NZTA guide
NZTA M/4 Class 3	Unbound	MA	MA FBS / BBB	FBS	Refer to NZTA guide
NZTA M/4 Class 4	MA	MA FBS* / BBB	MA FBS* / BBB	Refer to NZTA guide	Refer to NZTA guide

- MA – Modified Aggregate
- FBS – Foamed Bitumen Stabilisation
- BB – Bitumen Bound Basecourse

Source: AQA/CCNZ

Selection of Suitable Binder/s

- Amount and quality of fines (<0.075mm) determines binder type and how much.
- Range of binders can be used depending on properties requiring modification.
- Historical use of KOBM as a modifier is coming to an end requiring alternatives.

Table 2.4: Preliminary selection of binder/additive type

Particle size	**More than 25% passing 75 µm sieve**			**Less than 25% passing 75 µm sieve**		
Plasticity index (PI)	PI ≤ 10	10 < PI < 20	PI ≥ 20	PI ≤ 6 & PI x %passing 75 µm ≤ 60	PI ≤ 10	PI > 10
Binder type						
Cement and cementitious blends[1,3]	Usually suitable	Doubtful	Usually not suitable	Usually suitable	Usually suitable	Usually suitable
Lime	Doubtful	Usually suitable	Usually suitable	Usually not suitable	Doubtful	Usually suitable
Bitumen	Doubtful	Doubtful	Usually not suitable	Usually suitable	Usually suitable	Usually not suitable
Bitumen/ lime blends	Usually suitable	Doubtful	Usually not suitable	Usually suitable	Usually suitable	Doubtful
Granular	Usually suitable	Usually not suitable	Usually not suitable	Usually suitable	Usually suitable	Doubtful
Dry powder polymers	Usually suitable	Usually suitable	Usually unsuitable	Usually suitable	Usually suitable	Usually not suitable
Other proprietary chemical products[2]	Usually not suitable	Usually suitable	Usually suitable	Usually not suitable	Doubtful	Usually suitable

1. *The use of some chemical binders as a supplementary addition can extend the effectiveness of cementitious binders in finer soils and soils with higher plasticity.*
2. *Should be taken as a broad guideline only. Refer to trade literature for further information.*
3. *TMR uses triple blend and have a method based on % passing 0.425 mm sieve and linear shrinkage (Volker & Hill 2016).*

Source: TMR

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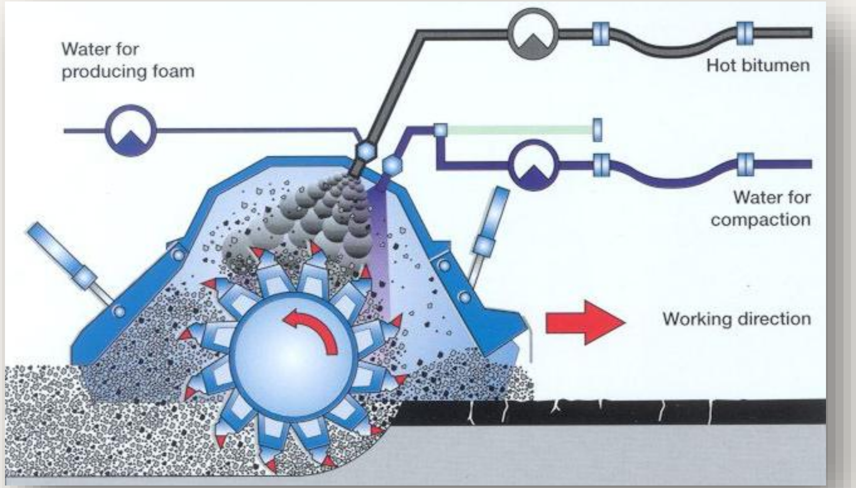
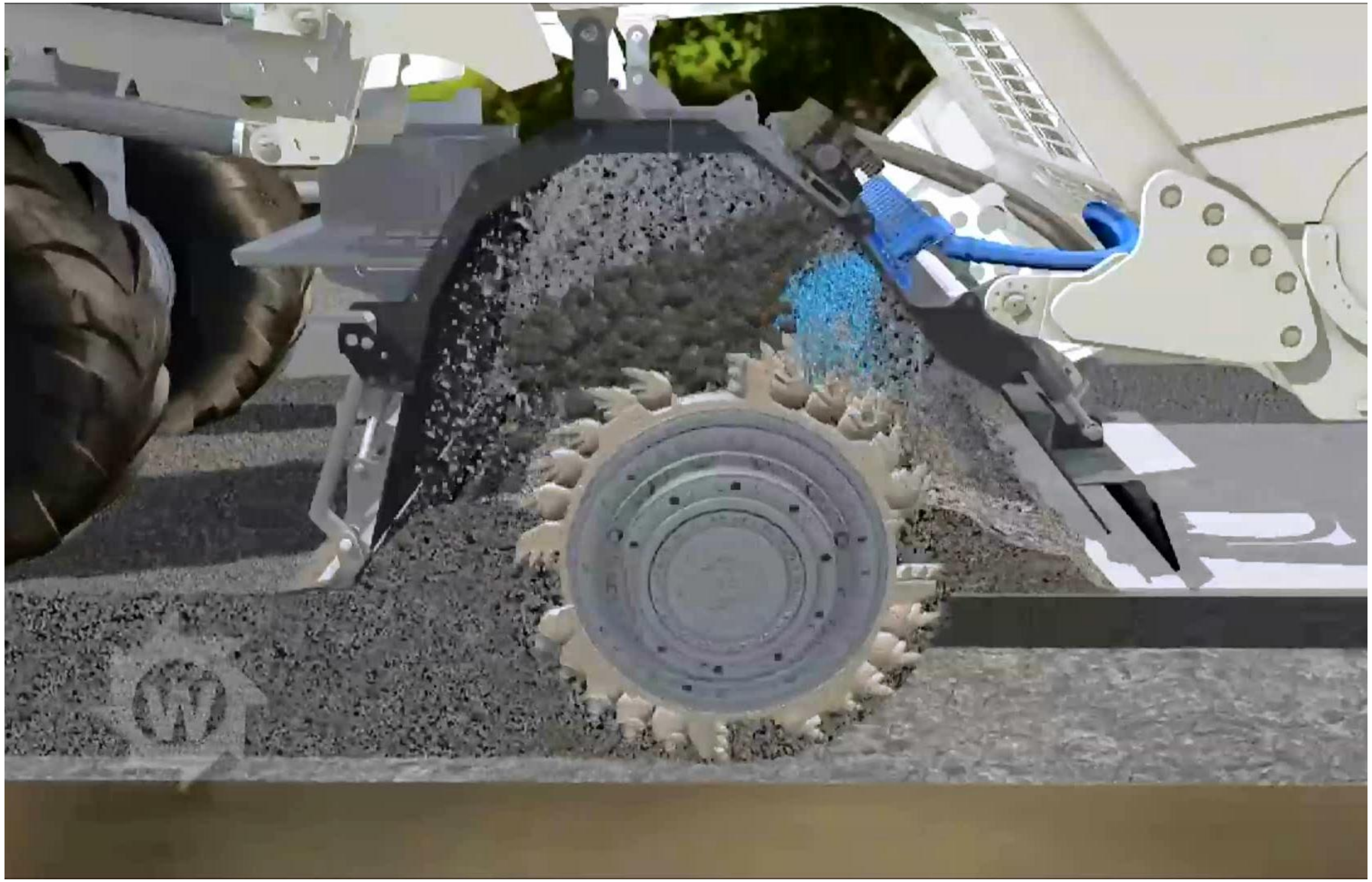
In-situ stabilisation – Cement and Foamed Bitumen Recycling





Source: Wirtgen / SABITA TG02

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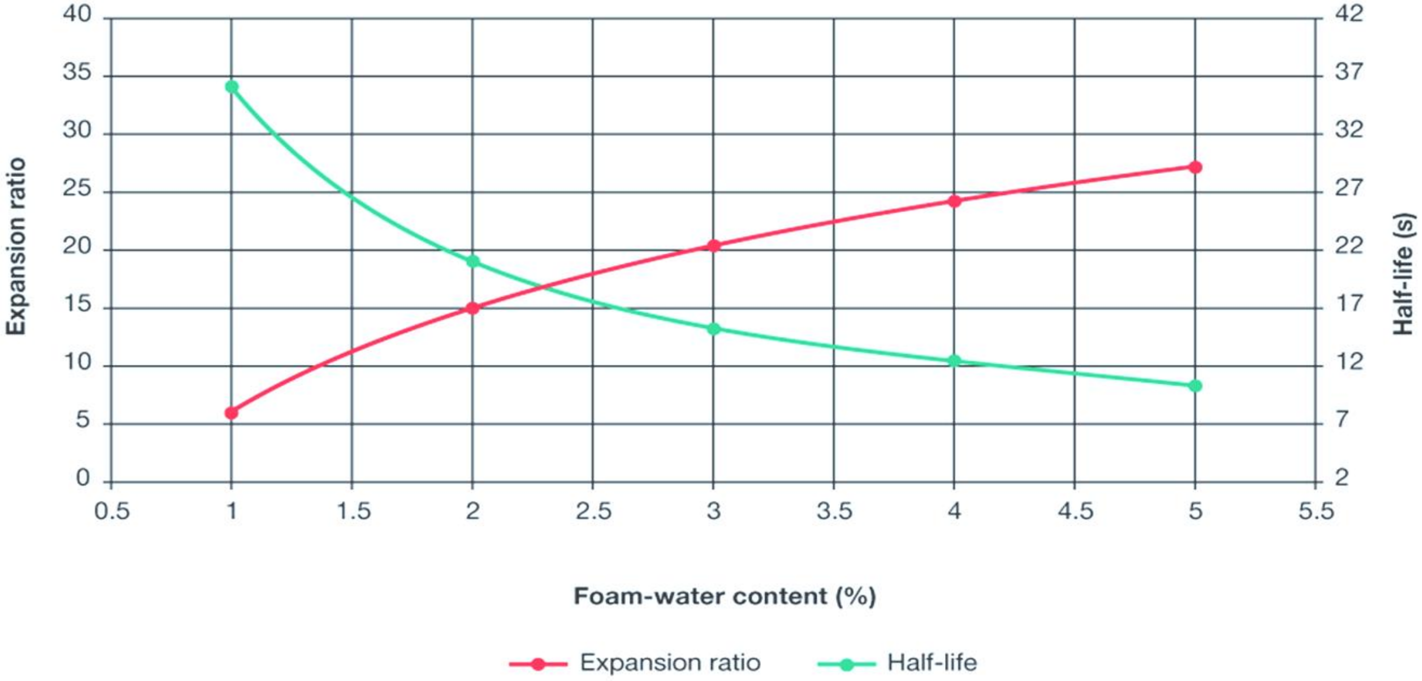
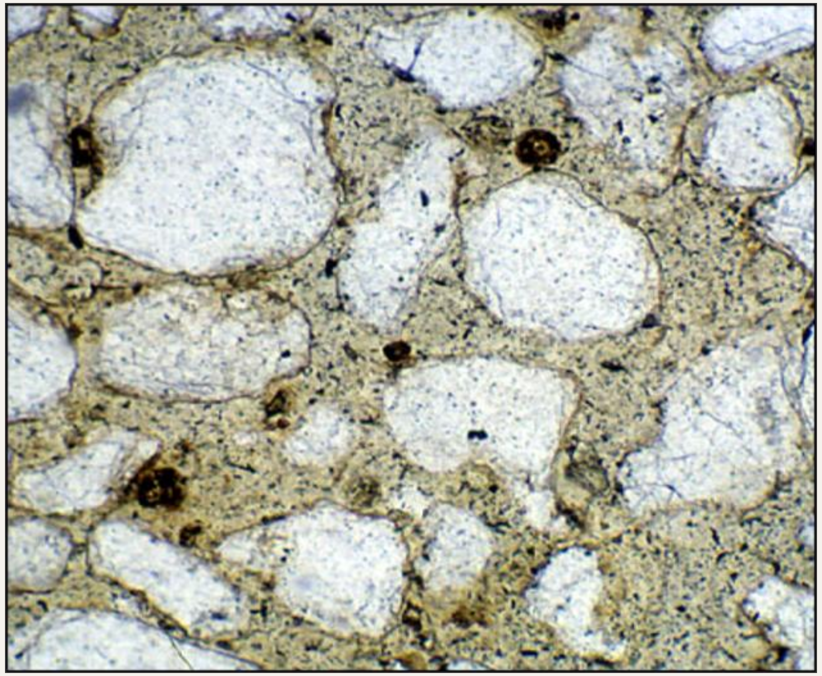
Bitumen Compatibility



Foamed Bitumen Recycling

- Bitumen is foamed in pugmill to allow the bitumen particles adhere to the aggregate.



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Foamed Bitumen Recycling - ITS and Modulus

- NZTA T/19 used to determine Indirect Tensile Strength (ITS)
- SABITA TG2 consulted for operating parameters
- Wirtgen literature specifies alternative requirements that Hiway follow

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FOAMED BITUMEN DESIGN ANALYSIS					
Aggregate FB40					
FB40 + 3% Bitumen + 1% Cement					
Initial Laboratory Testing					
BLOCK NUMBER	TYPE OF TEST	ITS (kPa)	BULK DENSITY t/m^3	DRY DENSITY t/m^3	MOISTURE CONTENT %
A	DRY	327	2.29	2.24	2.3
B	DRY	325	2.30	2.24	2.6
C	WET	293	2.33	2.25	3.6
D	WET	324	2.31	2.22	3.9
-	UCS (MPa)	3.00	2.30	2.25	2.5
AVERAGE					
DRY ITS AVE	326	WET ITS AVE	309	TSR	0.95
BULK DENSITY	2.30	DRY DENSITY	2.24	MOISTURE	2.47

ITSM MODULUS					
BLOCK NUMBER	HEIGHT (mm)	RESILIENT MODULUS (MPa)	MEAN RESILIENT MODULUS (MPa)	BULK DENSITY t/m^3	DRY DENSITY t/m^3
1	86.0	3339		2.282	2.23
2	88.8	3902	3499	2.305	2.249
3	85.5	3256		2.283	2.232

DESIGN ANALYSIS SUMMARY					
TYPE	AVE. ITS	TSR	UCS	MODULUS 1	MODULUS 2
FB40 + 3% Bitumen + 1% Cement					
MIX DESIGN	326	0.95	3.0	2493	1072

NZTA T19:2020 Notes - ITS Guidance

NZTA T19:2020: Notes for ITS Testing of Modified and Bound Pavement Materials

Table 1: Guidance for Indirect Tensile Strength (ITS)

Pavement Layer Type	Dry ITS (kPa)	Soaked ITS (kPa)
Cement / Lime Modified Basecourse	150 to 350	100 to 300
Foamed Bitumen Stabilised Basecourse	175 to 400	150 to 350
Cement Bound Subbase	> 500	> 450

Source: NZTA T/19 Notes

Suitability of an Aggregate for Foamed Bitumen Stabilisation

- Not all aggregates are created equal
- NZTA M/4 doesn't provide the aggregate characteristics required.
- Review of international specification to understand aggregate requirements.

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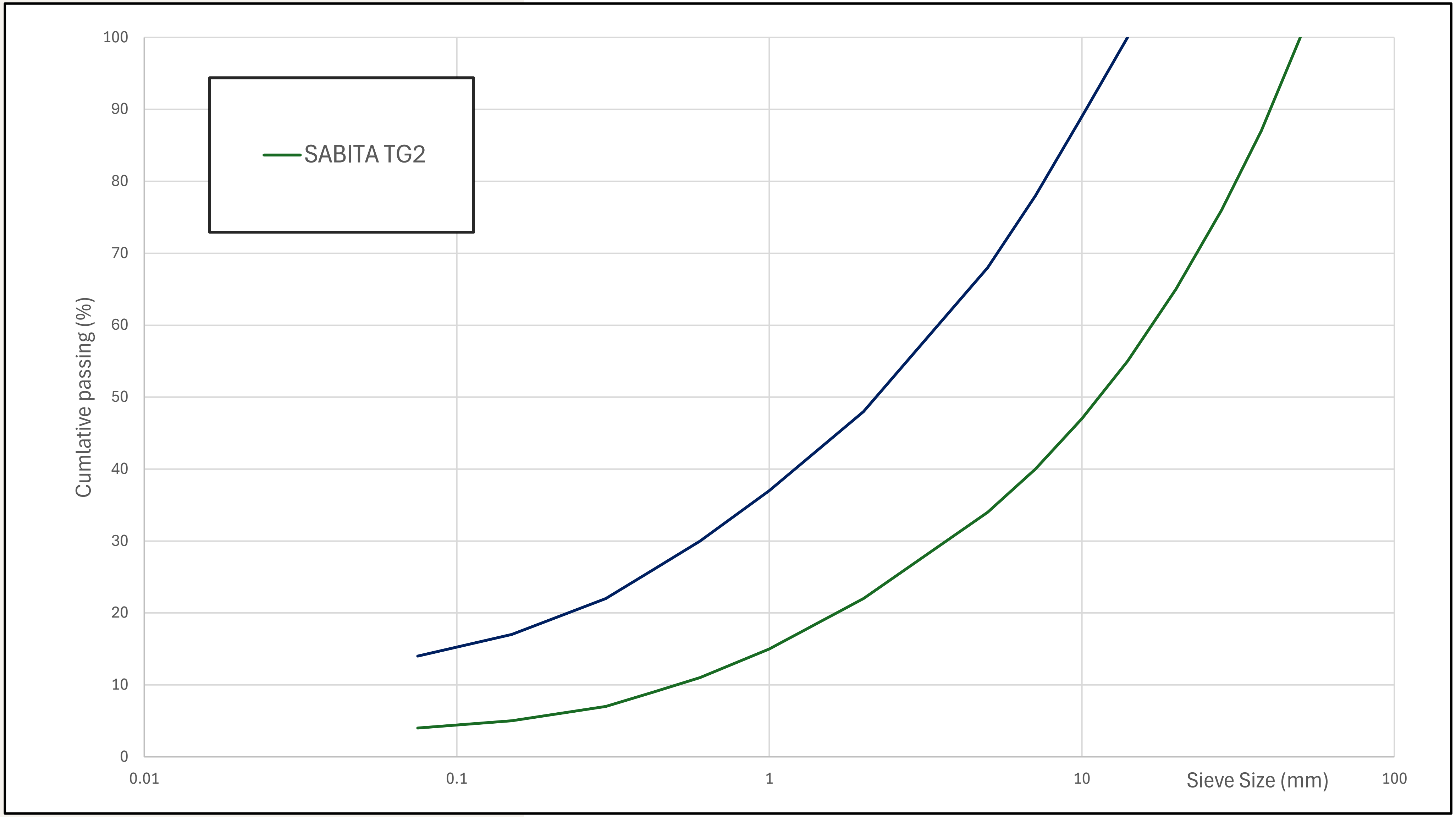
Particle Size Distribution



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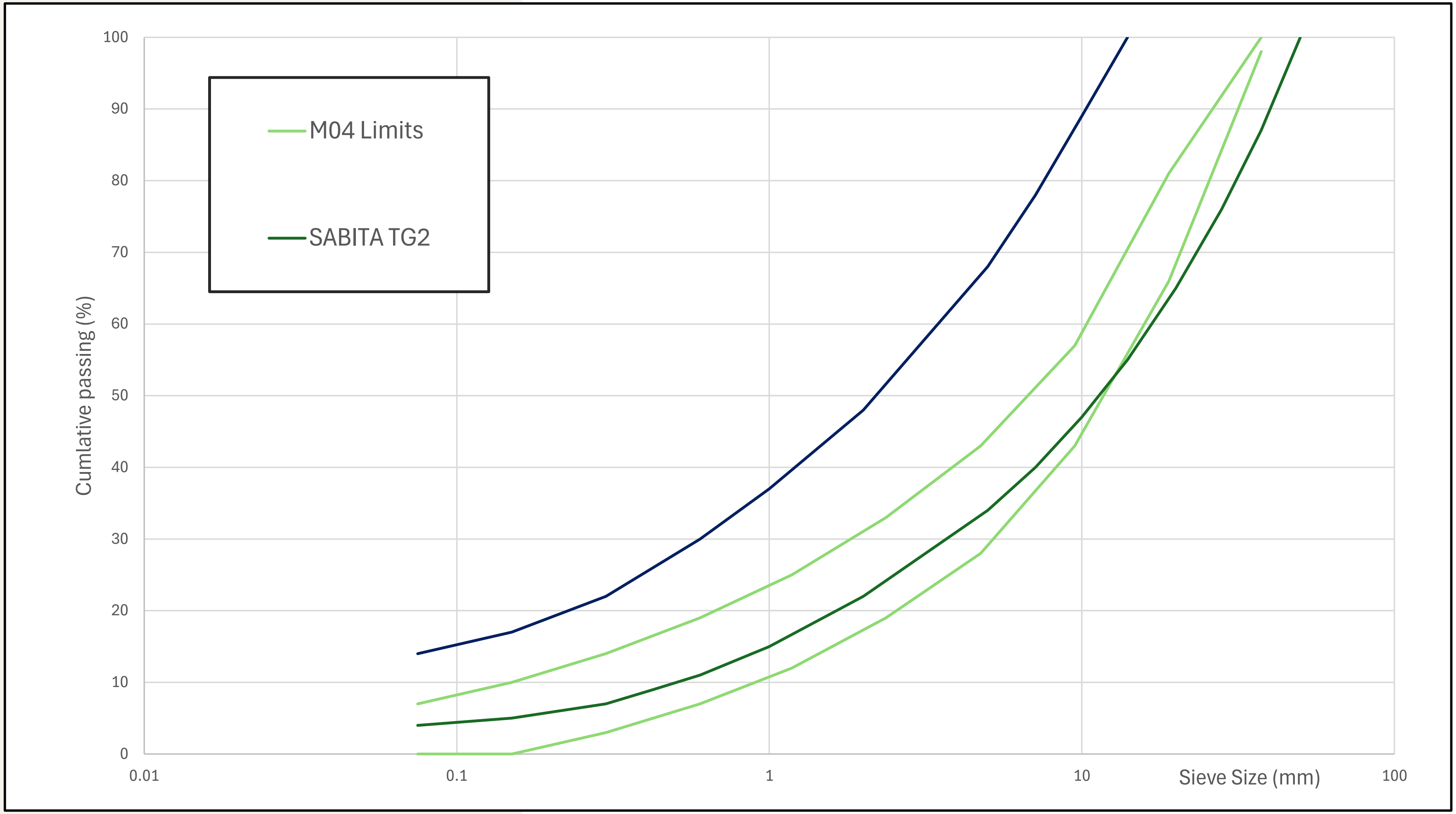
Particle Size Distribution



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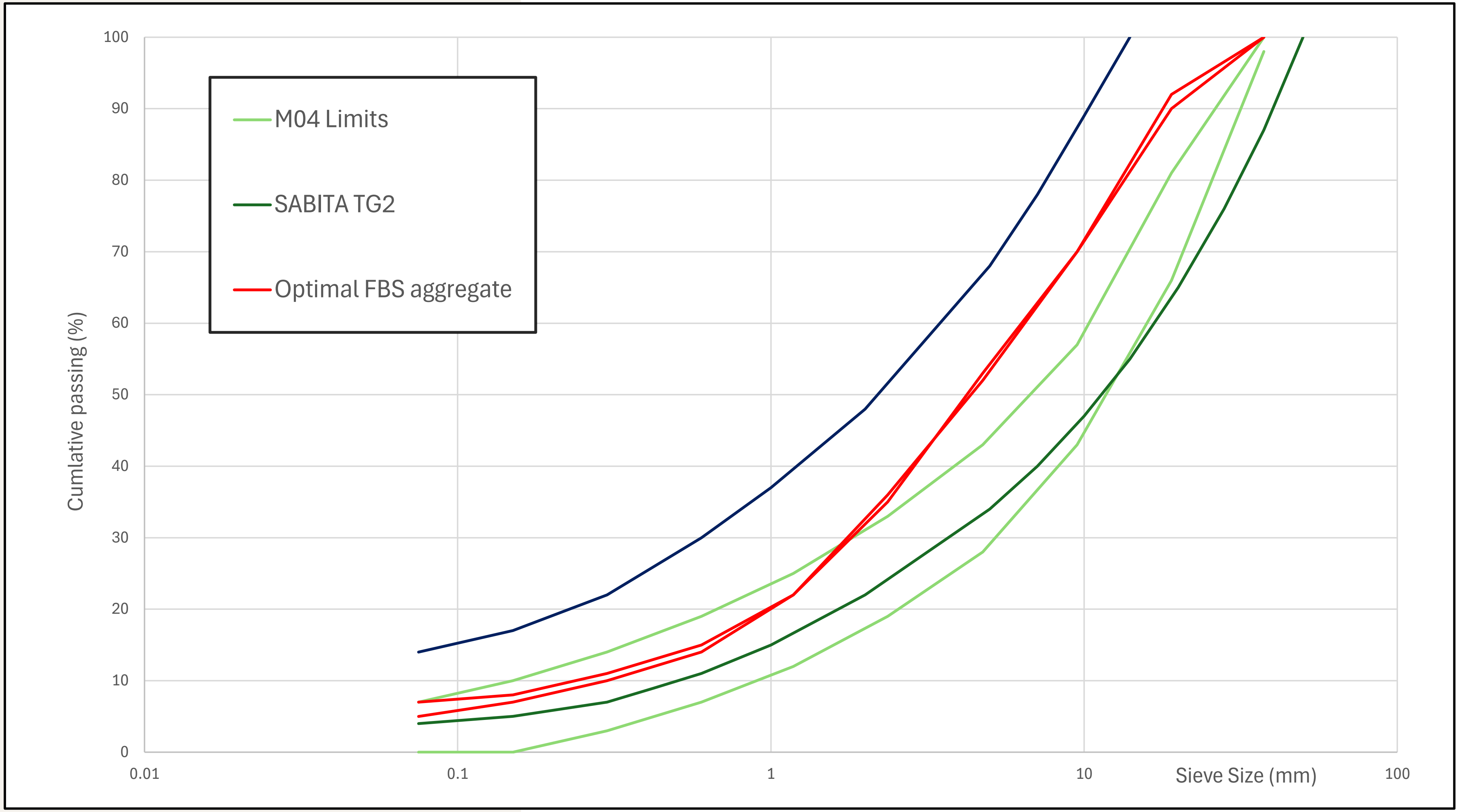
Particle Size Distribution



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Quality of Fines

Quality of Fines Criteria	
Plasticity Index	• Ideally non plastic. • Between NP & 10, aggregate is ok for use. • >10, pre-treatment required. Increased risk of pavement cracking.
Clay Index	• <3, ideal, indicates low clay particle content • Above 3, can be used, determine Plasticity Index prior to use.
Sand Equivalent	>30, not so relevant as high %age fines can lead to low SE values but the aggregate will work well with bitumen foam

Test criteria and frequency

Test	Criteria	Frequency of testing
Particle Size Distribution		2 tests - lots <400m^3 3 tests – lots 400m^3 – 1500m^3 4 tests – 1,500m^3 – 4,000m^3 1 additional test per 1,000m^3
PI, CI &/or SE	PI < 10 CI < 3.0 SE > 30	2 tests - lots <400m3 3 tests – lots 400m3 – 1500m3 4 tests – 1,500m3 – 4,000m3 1 additional test per 1,000m3
Crushing Resistance	<10% @ 130kN	1 per 10,000m^3
Weathering Quality Index	AA, AB, AC, BA, BB or CA	1 per 10,000m^3
Solid Density	Report	1 per 10,000m^3

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Conclusion

- Aggregates aren't created equal and one size does not fit all. Bespoke options required at times.
- Aggregate properties determine how they can be treated for achieve performance outcomes.
- Consideration should be given to binder selection to achieve performance outcomes based on aggregate properties.
- Additional quarry processing maybe required.