Sand Grading Exponent (SGE)

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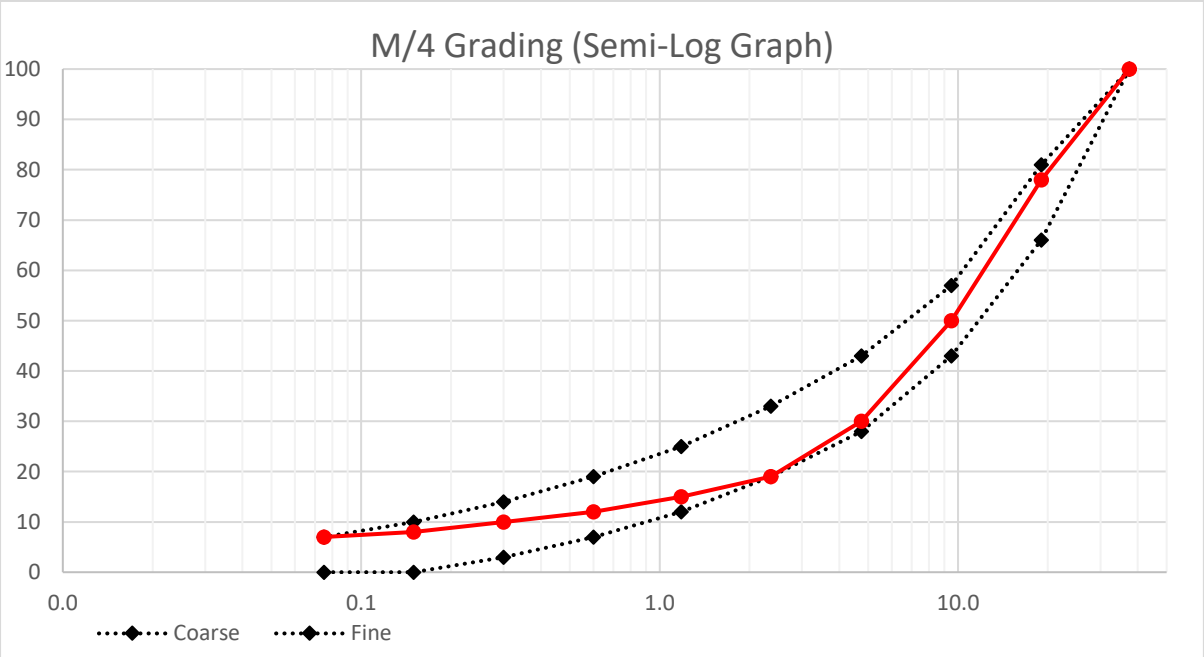
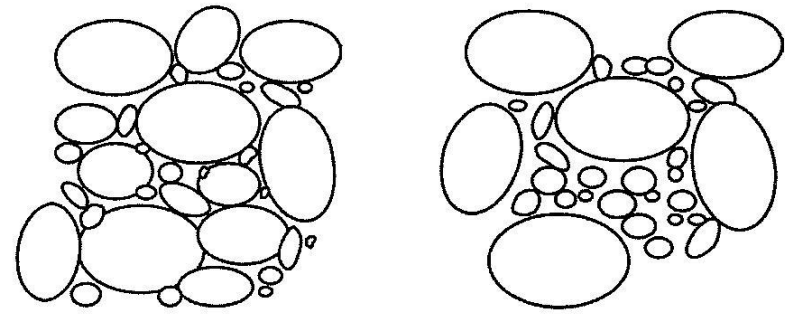
Back in 2011, a research report for NZTA looked at premature failure of unbound pavements, collected a dataset of problem basecourses and subbases and looked for common issues, mainly identified as basecourses with a long-term high degree of saturation. (When moisture takes over all the air voids.)

The basecourses most likely to be saturated were those with a gap grading in the sand fraction. A gap grading means some of the particle sizes are missing or lower than they should be, which lets a basecourse pack down more easily and lose its air voids.

On a test report, a gap grading looks like the grading curve that has a kink in it, instead of being smooth (see picture below). In terms of aggregate sizes, the illustration from The Aggregates Handbook shows the gap-graded example will be less stable and less desirable than the well-graded one.



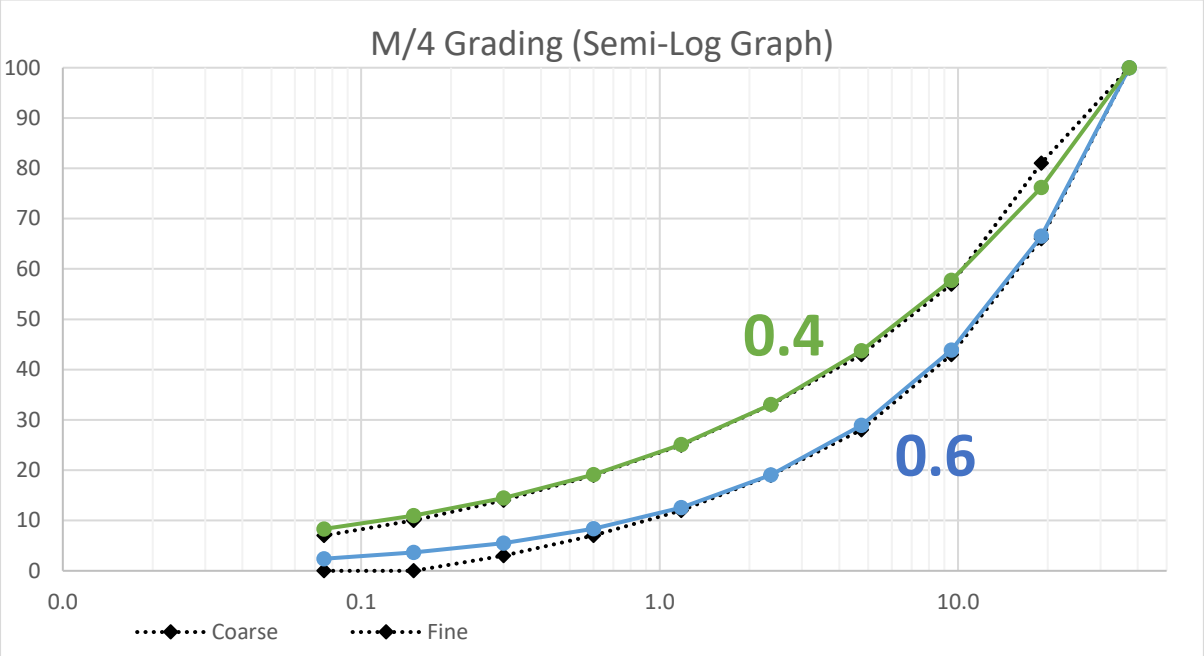
Gap graded particle size distribution – note the change from coarse to fine. This material is lacking fine sand but passes M/4.



Example of a Well-Graded Aggregates

Example of a Gap-Graded Aggregates

The research calculated which sand grading curve shapes were most risky using their **exponents**. Exponents are the number of times you multiply a number or calculation (raising to the power of…). For example, 2 exponent 3 is $2^3 = 8$. If you look at it in terms of our M/4 grading limits, you can see that the fine side closely follows an exponent of 0.4 and the coarse side closely follows 0.6. If your basecourse had a constant exponent of 0.5 you'd be very happy!



The M/3 Notes for subbase from 1986 talk about exponent limits on grading of 0.4 and 0.7 so this is not a new concept, just looking at the sand fraction (<4.75mm) more critically.

The 2011 research report also included recommended changes to M/3 and M/4 to include the SGE calculation. NZTA held off a requirement of passing the SGE until 2017 when it was introduced in the guide used for the rehabilitation of state highways, the Rehab Guide.

In 2018, Auckland Transport picked up the SGE and inserted it into their contract for the AMETI Eastern Busway contract.

So what is SGE?

- It's a calculation of the grading shape exponent in the sand fraction of a basecourse
- It's free to work out – you just need to do some maths
- There are 4 calculations done on the sand fraction and the average of the lowest two is taken

Sieve size (mm)	%Passing	Critical Range	Grading Exponent
4.75	44	4.75 mm - 0.30mm	0.41
2.36	33	2.36 mm - 0.15 mm	0.43
1.18	25	1.18 mm - 0.15 mm	0.44
0.6	19	0.60 mm - 0.15 mm	0.46
0.3	14	**Ave. of 2 Lowest Exp.**	**Pass/Fail**
0.15	10	0.42	Pass

- According to the research, if your SGE result is less than 0.4, that flags that you might have a poor performing basecourse and you need to do something about it

While it's not an instant fail, just a flag – you have to get a Repeated Load Triaxial (RLT) test done to show your material is acceptable, costing $1000-1500 and taking some weeks.

The AQA Technical Advisory Group has been trying to get NZTA to listen to increasing industry concerns about the weight put on one research report. In January, AQA Chief Executive Wayne Scott took the issue public, saying the additional SGE requirements for M/4 basecourse were over the top and if put in place would blow out the cost of road building if adopted more widely.

NZTA's response was that "*additional checks' have been in place since mid-2017 for material used in key freight roads and we have consulted with industry on this issue."* NZTA confirmed the checks "*have been introduced in response to research showing that where basecourse aggregate doesn't conform to necessary shape requirements it may cause a failure in the pavement."*

Wayne Scott says one report done eight years ago is not a sufficient basis to embark on potentially wide-ranging new requirements to the quarry sector.
"There were enough questions left unanswered in the research to mean that SGE wasn't adopted into mainstream M/4 basecourse specification at the time, only put into the Rehab Guide years later.

"Now, Auckland Transport has put SGE in a roading project specification. Very likely it will then be copied into the next spec, then the next and become very widespread. NZTA say this is not their fault but they are the leaders in NZ pavements and everyone tends to follow suit."