Rheological Comparison of Self-Compacting Concretes Prepared with High Filler – Low Water Ternary Slag Cement and Portland-Limestone Cement

Matthew Cruickshank

R&D Manager

Ecocem Materials

Why **H**igh **F**iller – **L**ow **W**ater Cements?

HFLW in Practice: ECOCEM’s ACT

Low Carbon SCC: HFLW vs. PLC

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4. Commonly used SCMs, like GGBS and fly ash, are not available in sufficient quantities.
5. **Blended cements prepared with SCMs that are sufficiently available geographically and in terms of volume are the best solution.**

Sustainability Metrics Developed by Damineli

Binder Intensity

$$b_{i,cs} = \frac{B}{CS}$$

Where:

$b_{i,CS}$ = binder intensity
B = mass of reactive binder per m^3 of concrete
CS = compressive strength at 28 days

CO_2 Intensity

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Favours low clinker %

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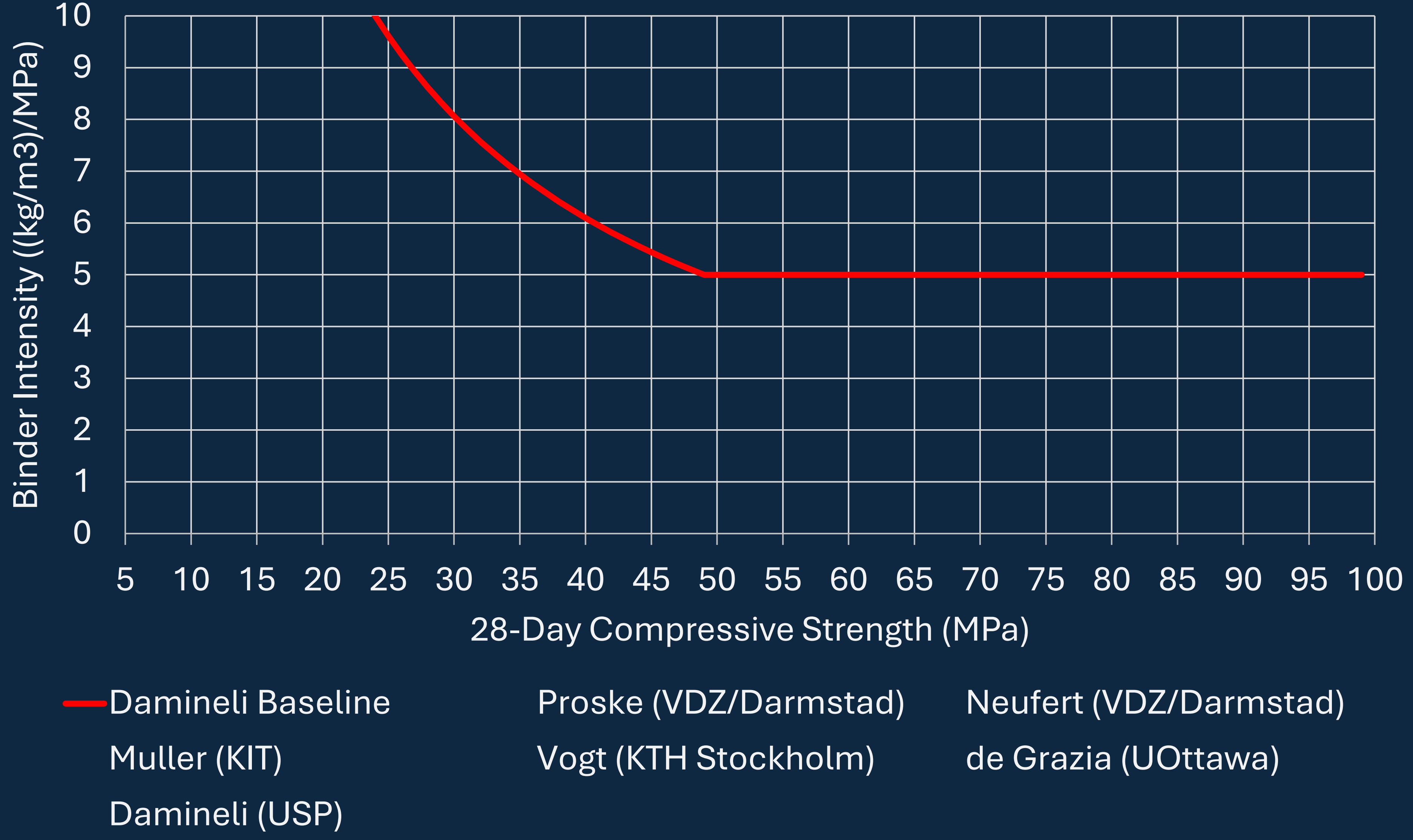

Binder Intensity ((kg/m3)/MPa)
10
9
8
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1
0
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10
15
20
25
30
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45
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75
80
85
90
95
100
28-Day Compressive Strength (MPa)
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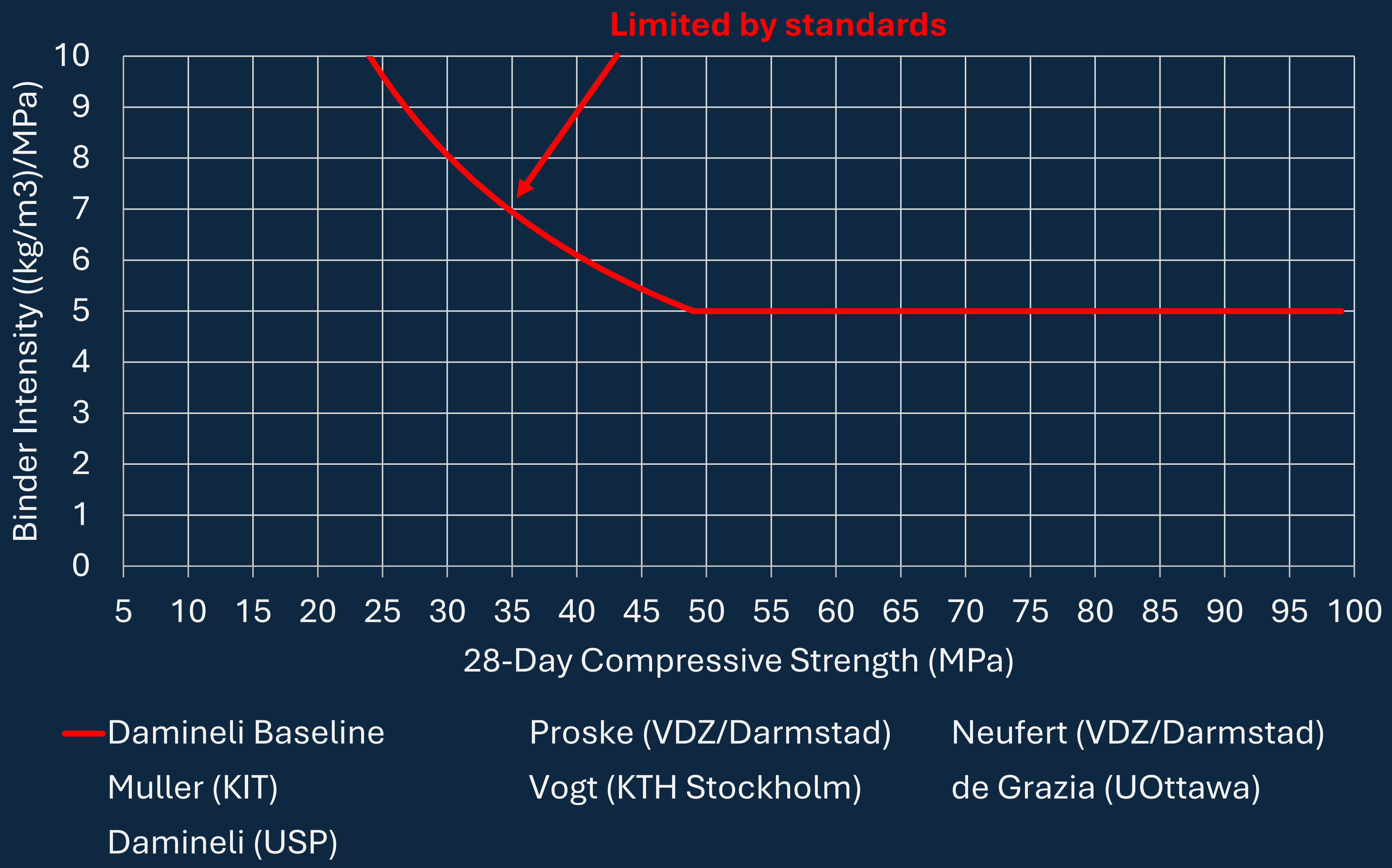

Limited by standards
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9
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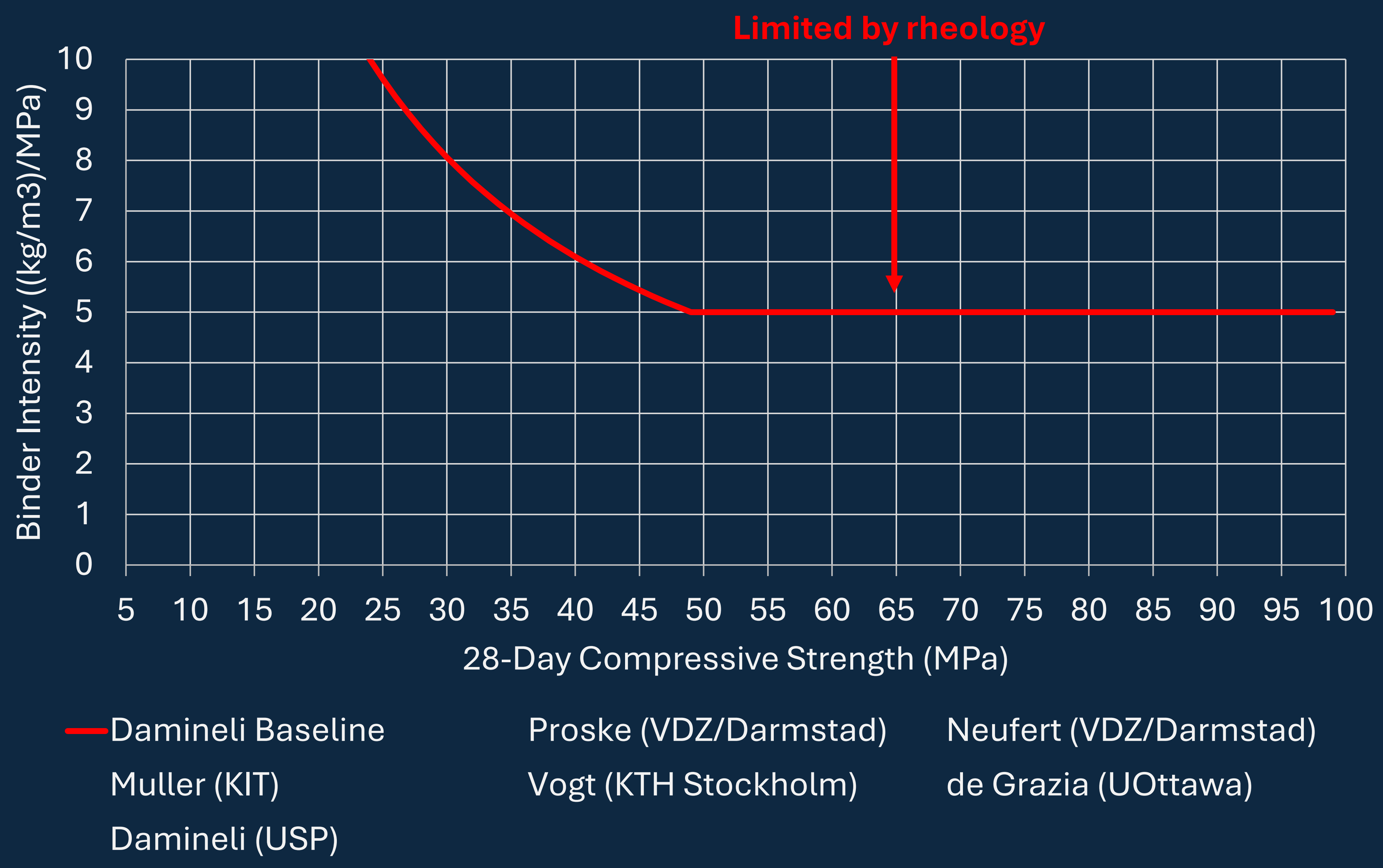
Limited by rheology
Binder Intensity ((kg/m3)/MPa)
10
9
8
7
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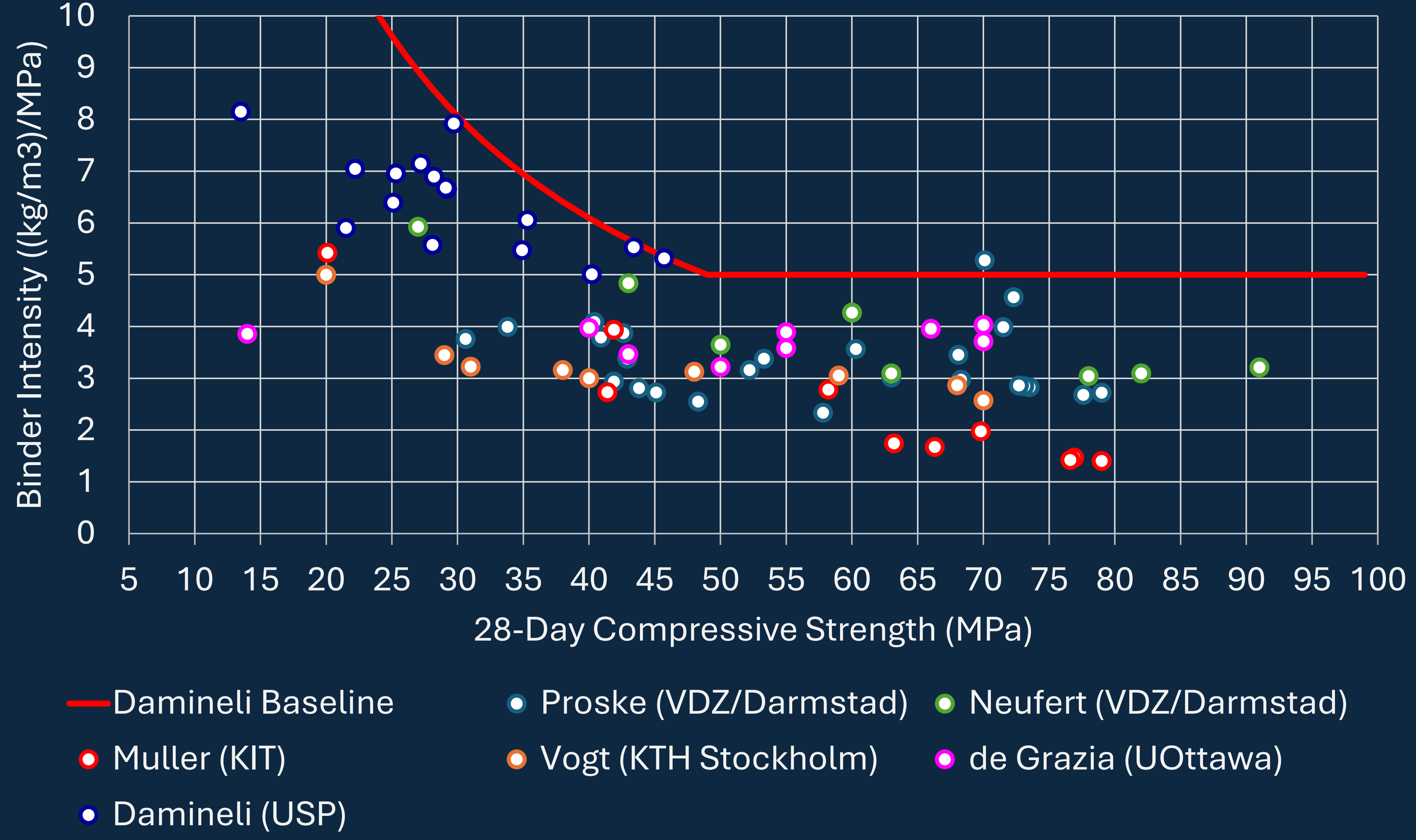

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- Strength
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Beyond slump, how is the rheology?

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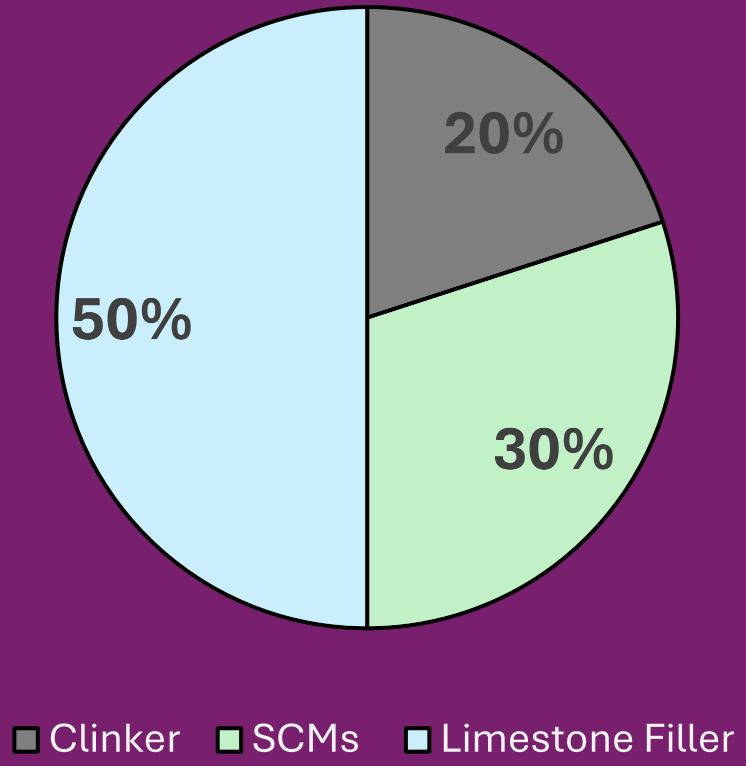
ECOCEM’s ACT Technologies

Typical ACT Formulation



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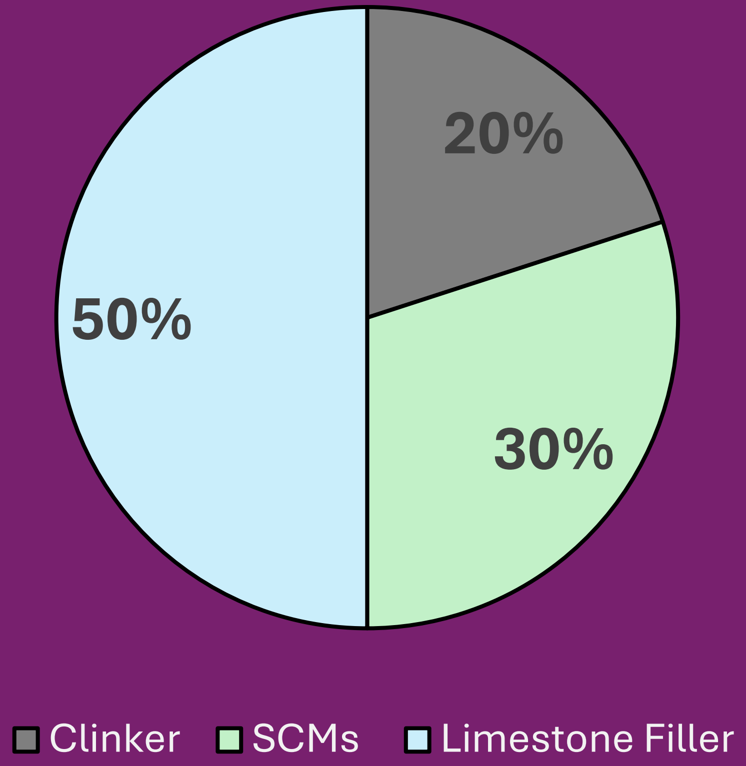

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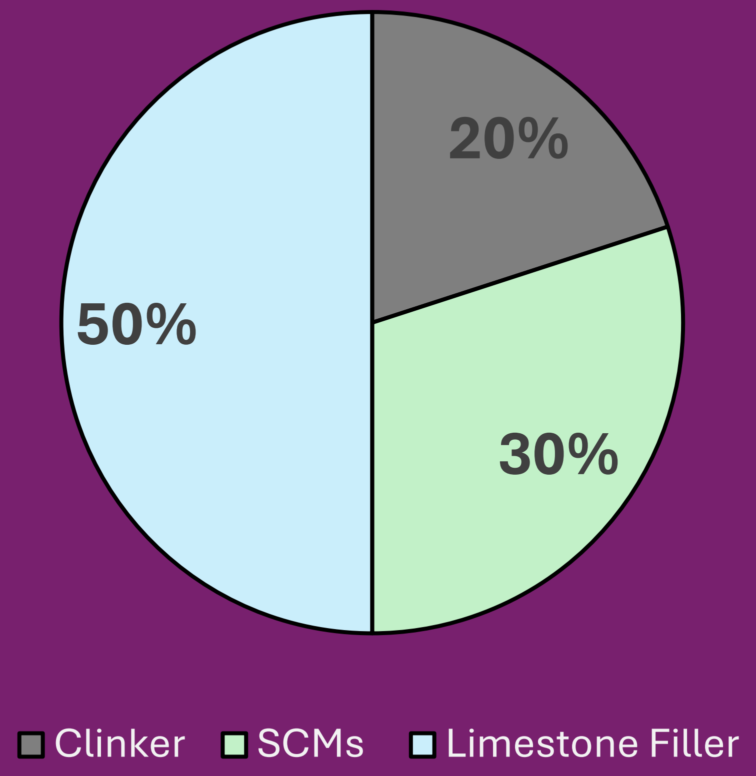

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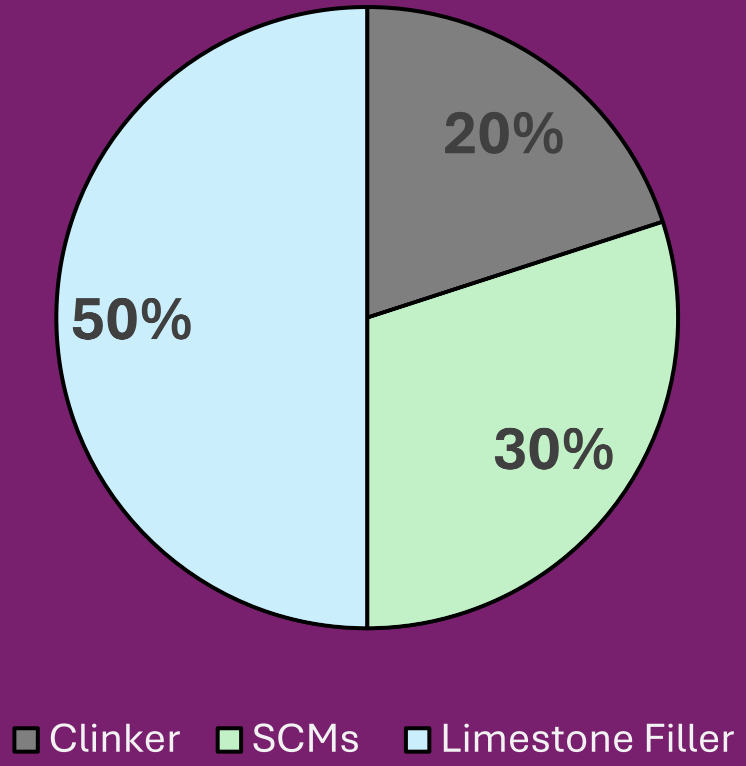

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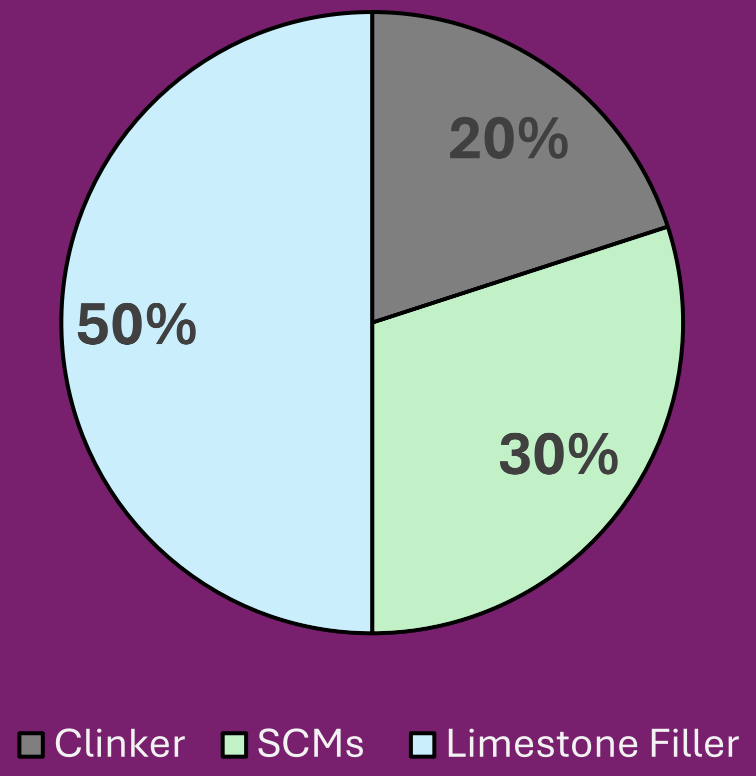

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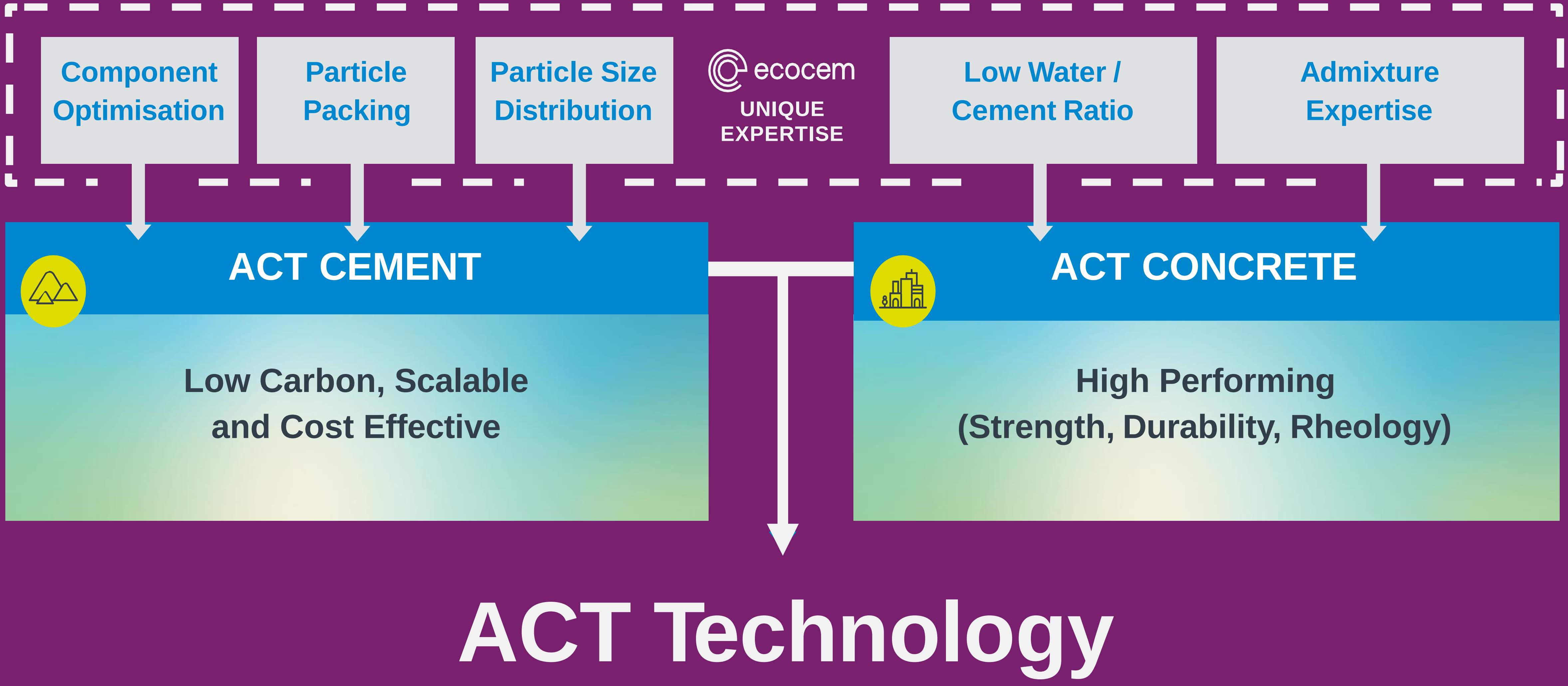
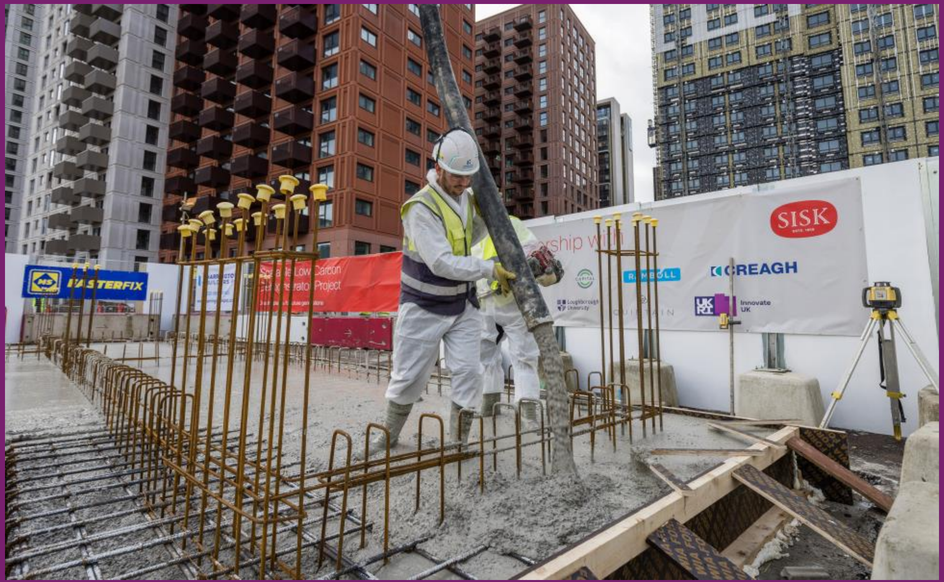


ACT in Ready-Mix Concrete


QUINTAIN
SISK
BUILDING TODAY
PREMIER MODULAR


FASTERFIX
SISK
CREAGH
RAMBOLL
Innovate UK


RAMCRETE


Scalable Low Carbon
Demonstrator Project
Creating places for future generations
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Case Study: ACT vs PLC in SCC

Performance Targets

Spread Flow:	700 mm
Strength:	50 MPa at 28 days

Minimal changes to mix design,
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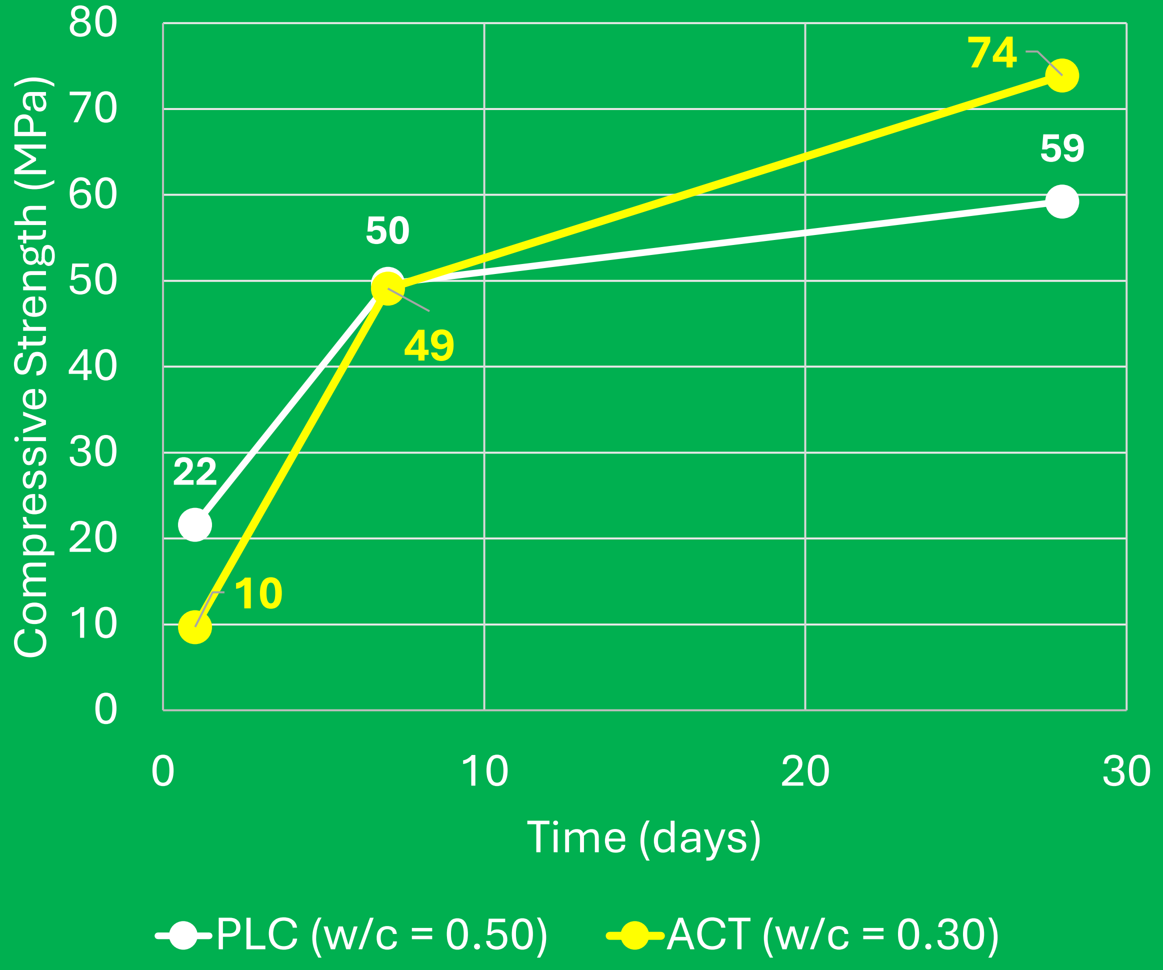
PLC **ACT**

ACT1 - GGBS

PLC vs Ecocem ACT – Mortar Testing



SCC - Mix Designs

		PLC	ACT
Sand (0/4 mm)	[kg/m³]	785	805
Gravel (2/6 mm)		200	220
Gravel (6/10 mm)		680	710
PLC		400	0
ACT		0	400
Ground Limestone		120	120
Effective Water		198	165
Admix 1	[% bwb]	0.75%	-
Admix 2		0.80%	-
Admix 3		-	0.84%
Admix 4		-	0.06%
Water/Cement	[-]	0.50	0.41
Water/Powder		0.38	0.32

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The differences in the w/c and w/p demonstrate the extent of the rheological challenge.

Fresh State Properties

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Spread Flow	[mm]	670	710
	[in]	26.4	28.0
V-Funnel	[s]	7	9
L-Box	[-]	0.92	0.89
Fresh	[kg/m³]	2347	2370
Density	[lbs/yd³]	3956	3994
Air Content	[%]	4.2	2.8

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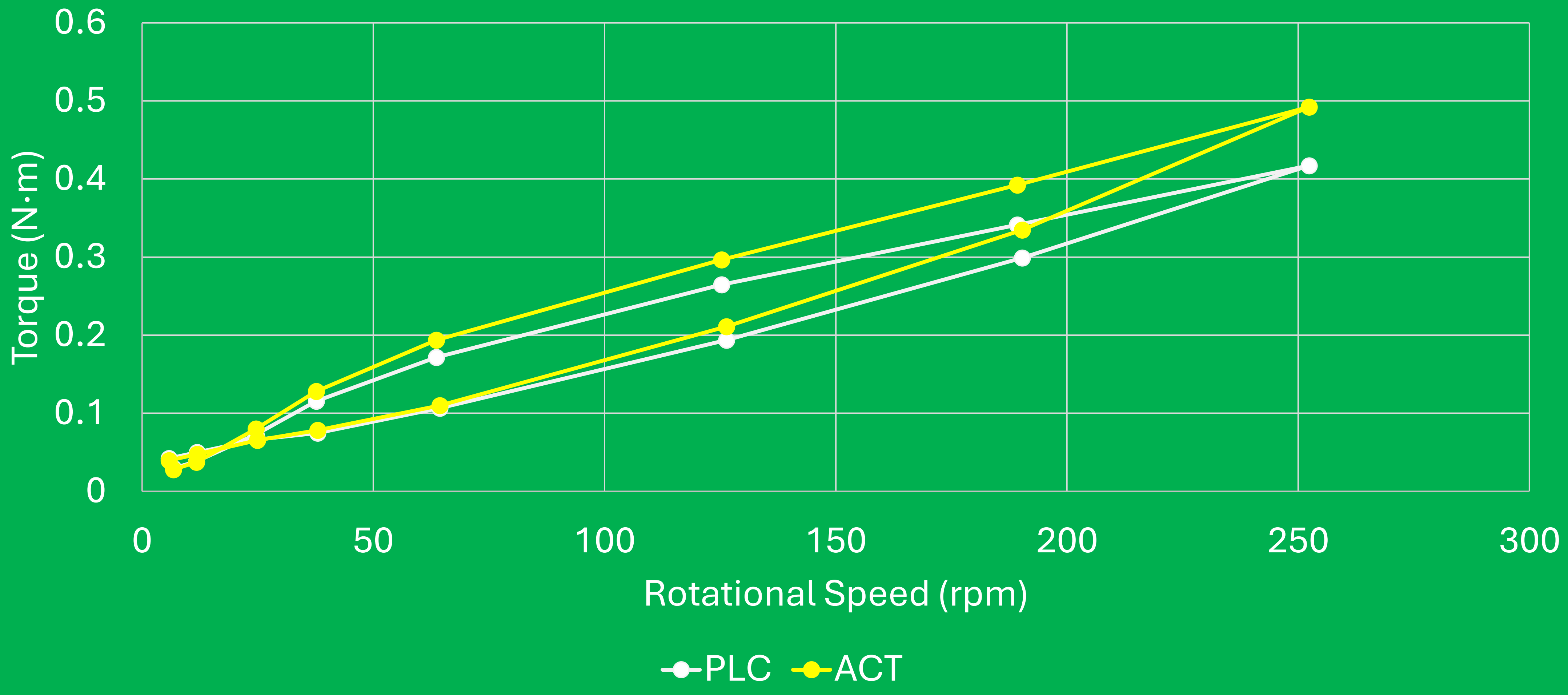
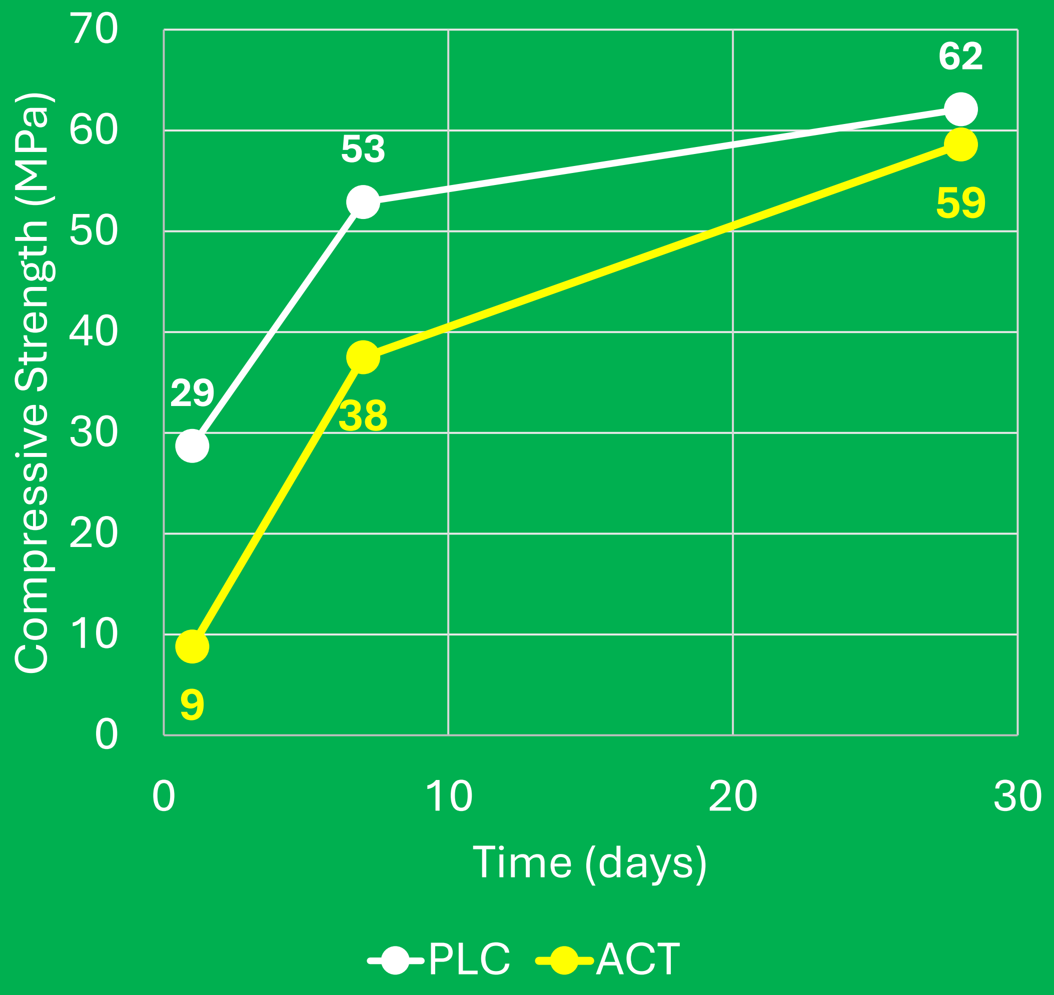
Both concretes exhibit strong self-leveling properties.

The higher air content measured with the PLC also favours lower viscosity.

Rotational Rheometry



Strength Development



ACT presents lower early strength development, but similar strengths are obtained at 28 days.

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PLC

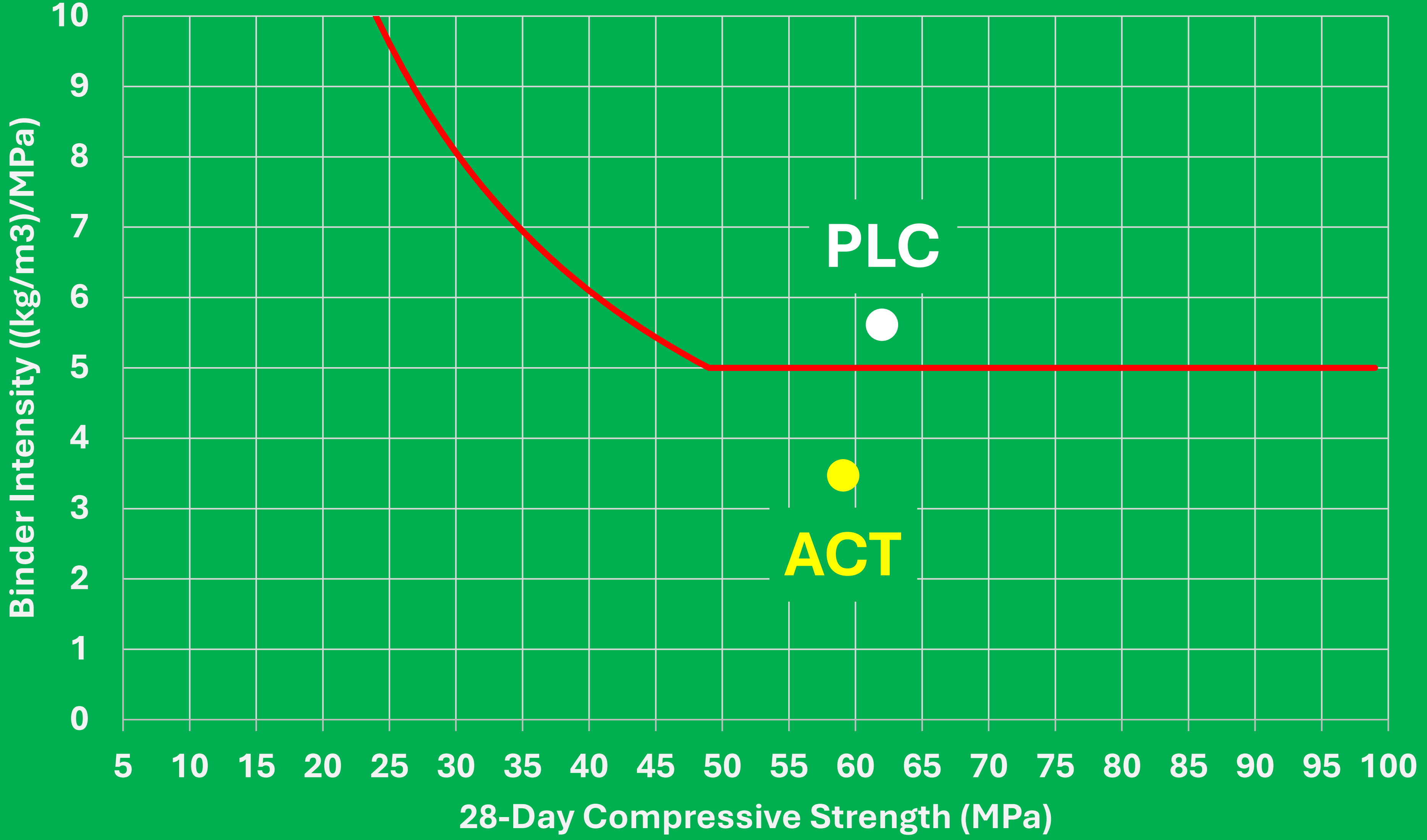
360 kg/m^3 clinker ÷ 62 MPa

5.8 $(kg/m^3)/MPa$

ACT

80 kg/m^3 clinker + 120 kg/m^3 GGBS ÷ 59 MPa

3.4 $(kg/m^3)/MPa$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