

Solvent-free Phenalkamines for Concrete Primers

October 2017



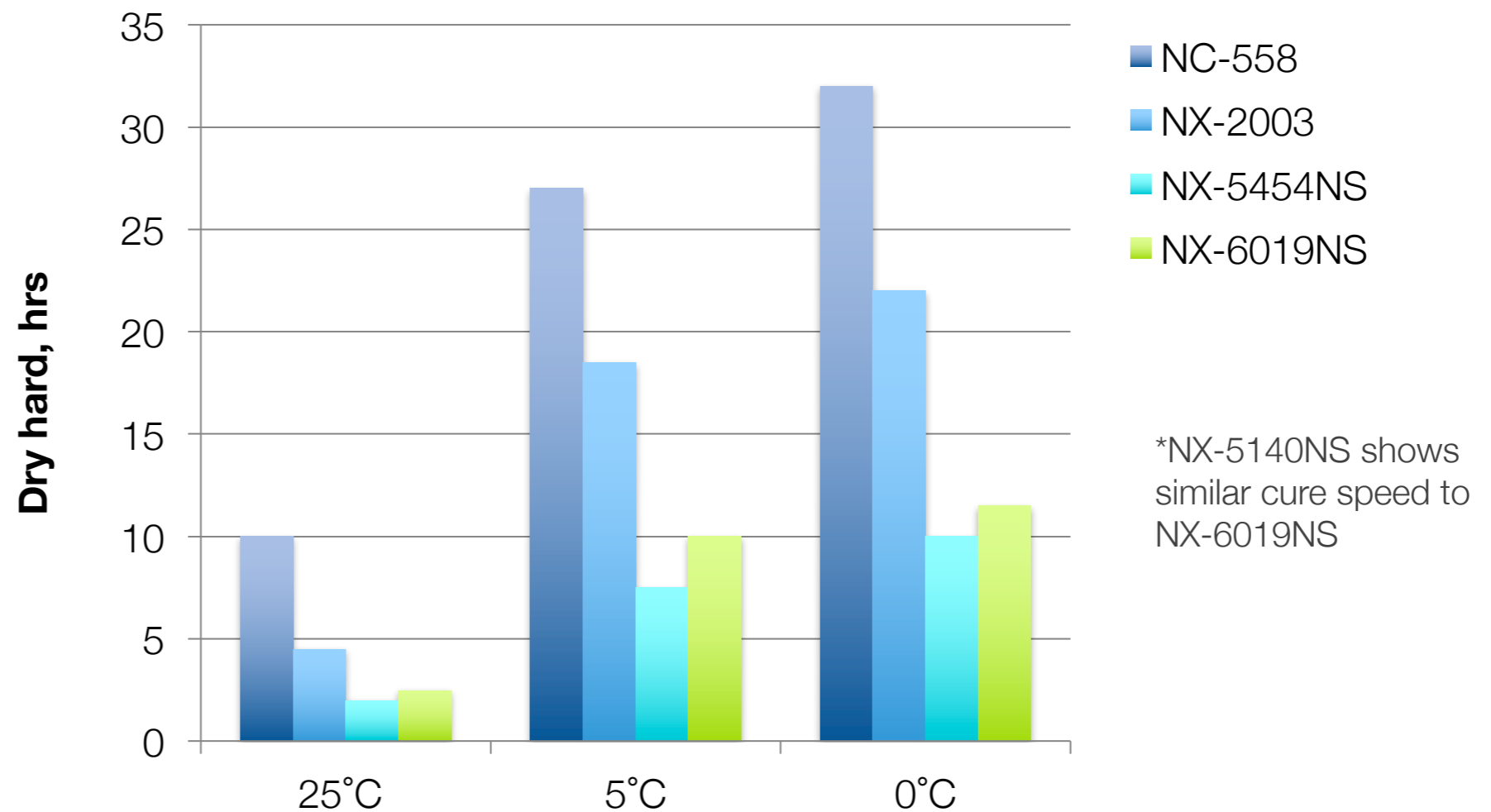
Properties	NC-558 *	NX-2003 *	NX-5454NS **	NX-6019NS **	NX-5140NS **
Viscosity @ 25°C (cPs)	500-1,500	500-1,300	700-1,200	800-1,600	600-1,200
Amine value (mg KOH/g)	320-360	330-375	270-310	260-300	260-300
Solvent/Benzyl Alcohol	no	no	no	no	no
AHEW	95	95	133	133	133
Color (Gardner)	≤17	≤10	≤14	≤14	≤10
Recommended PHR (EEW 190)	40-50	50	70	70	70
Gel time, 50g @25°C (min)	70 (50phr)	35	18	21	21

*LITE 558, NX-2003D, and LITE 2003 are also available

****Performance data developed with NX-5454NS, NX-6019NS, NX-5140NS are expected to be the same as for the respective non-NS versions and are used interchangeably in this presentation.**

Solvent-free Phenalkamines for Concrete Primers

Cure Speed with BADGE (190 EEW)

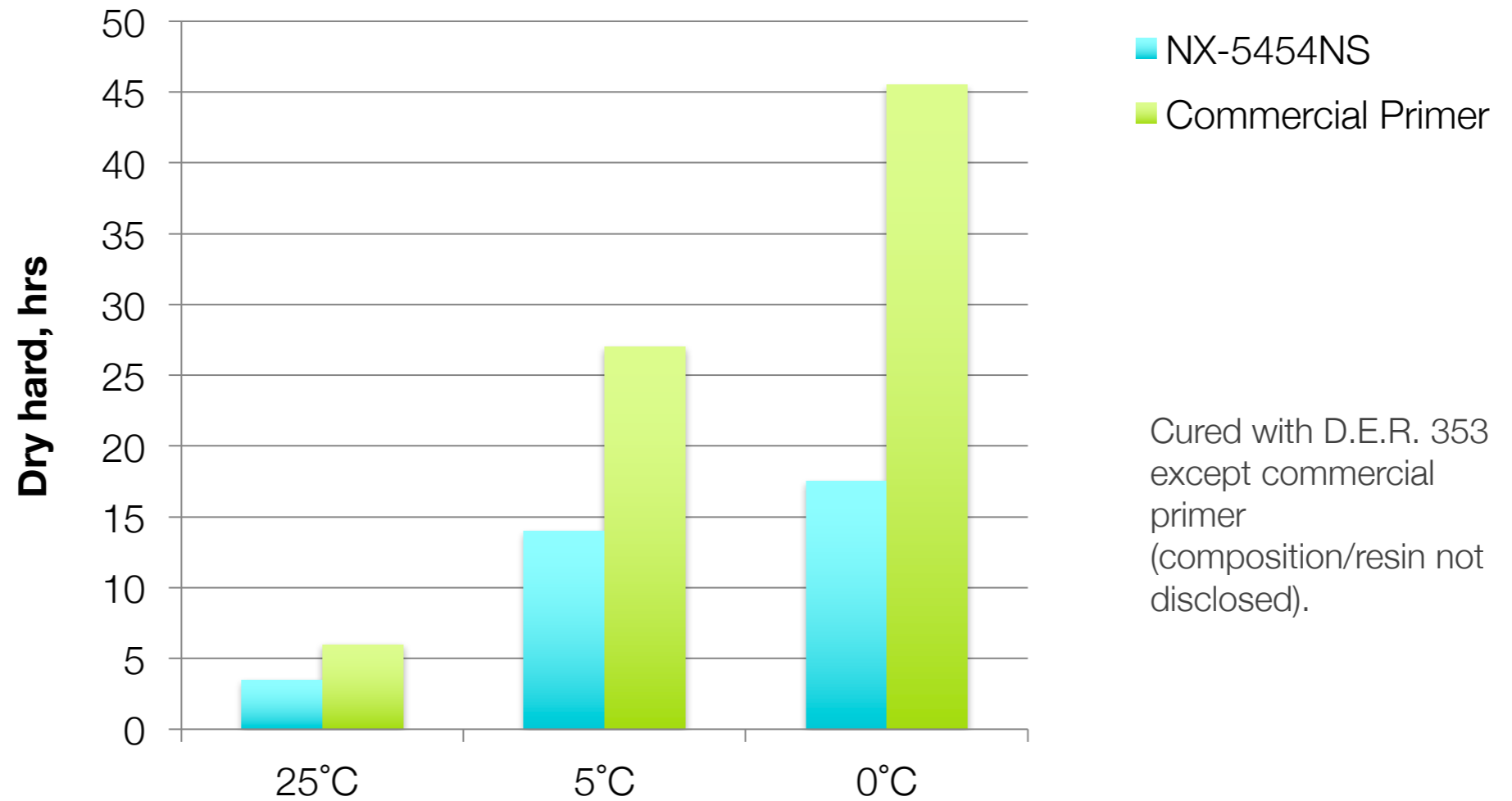


Phenalkamines show very fast cure even at low temperatures.

BK linear dry time (DFT 3~3.5mils) ASTM D5895



Cure Speed with D.E.R. 353



NX-5454NS shows faster cure than traditional commercial primers in a diluted BisA/F epoxy system. Same performance is expected with NX-6019NS and NX-5140NS.

BK linear dry time (DFT 3~3.5mils) ASTM D5895



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Film Appearance at Extreme Conditions

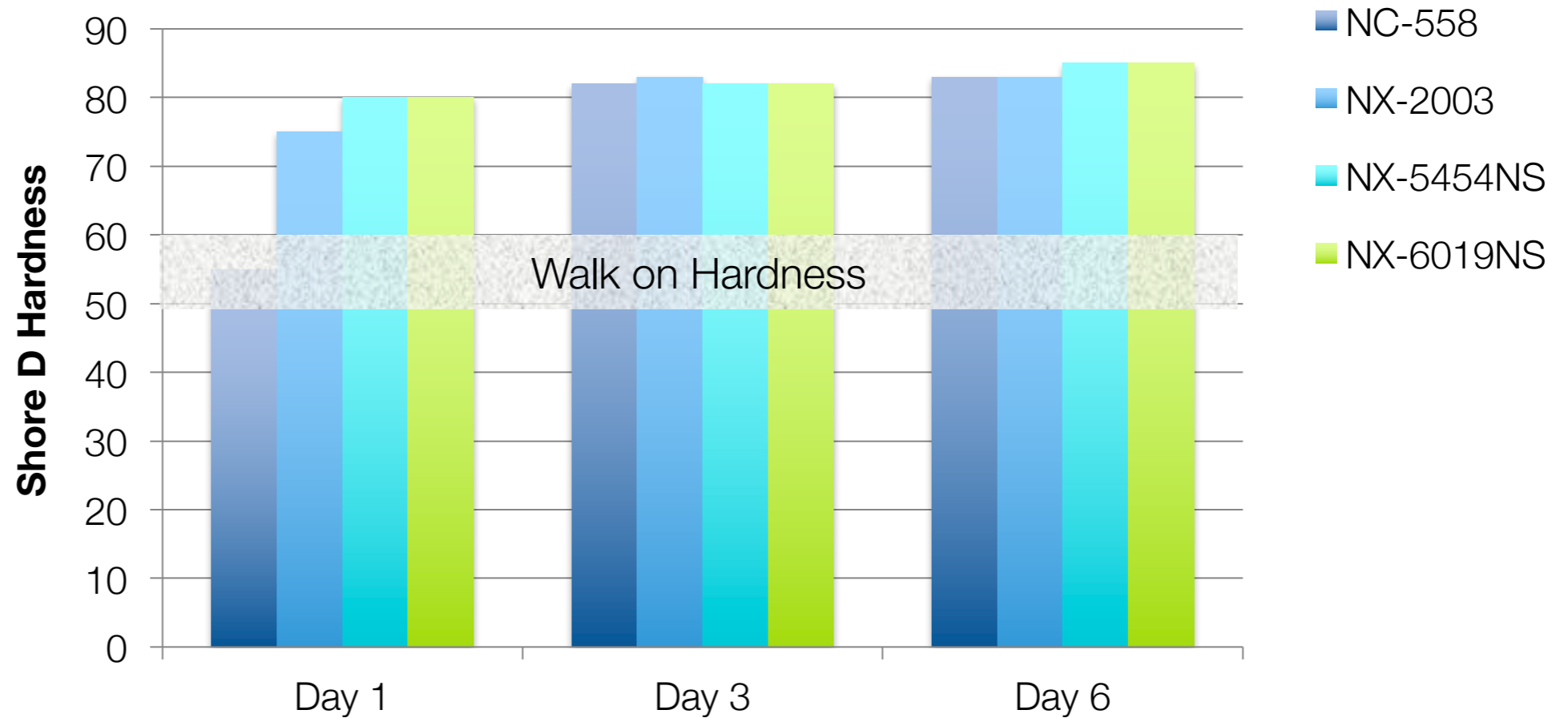
Curing Agent	10°C/92%RH with BADGE (190 EEW) and no induction
NC-558	Blush
NX-2003	Hazy
NX-5454NS	Clear, no blush
NX-6019NS	Clear, no blush
NX-5140NS	Clear, no blush
Commercial	Slight Haze

- ✓ NX-5454NS, NX-6019NS, NX-5140NS show no blush at 10°C / 92% RH
- ✓ Films for **all systems** are clear and glossy at room temperature and humidity <50%.



Hardness Development @ 25°C

25°C cured with BADGE (190 EEW)



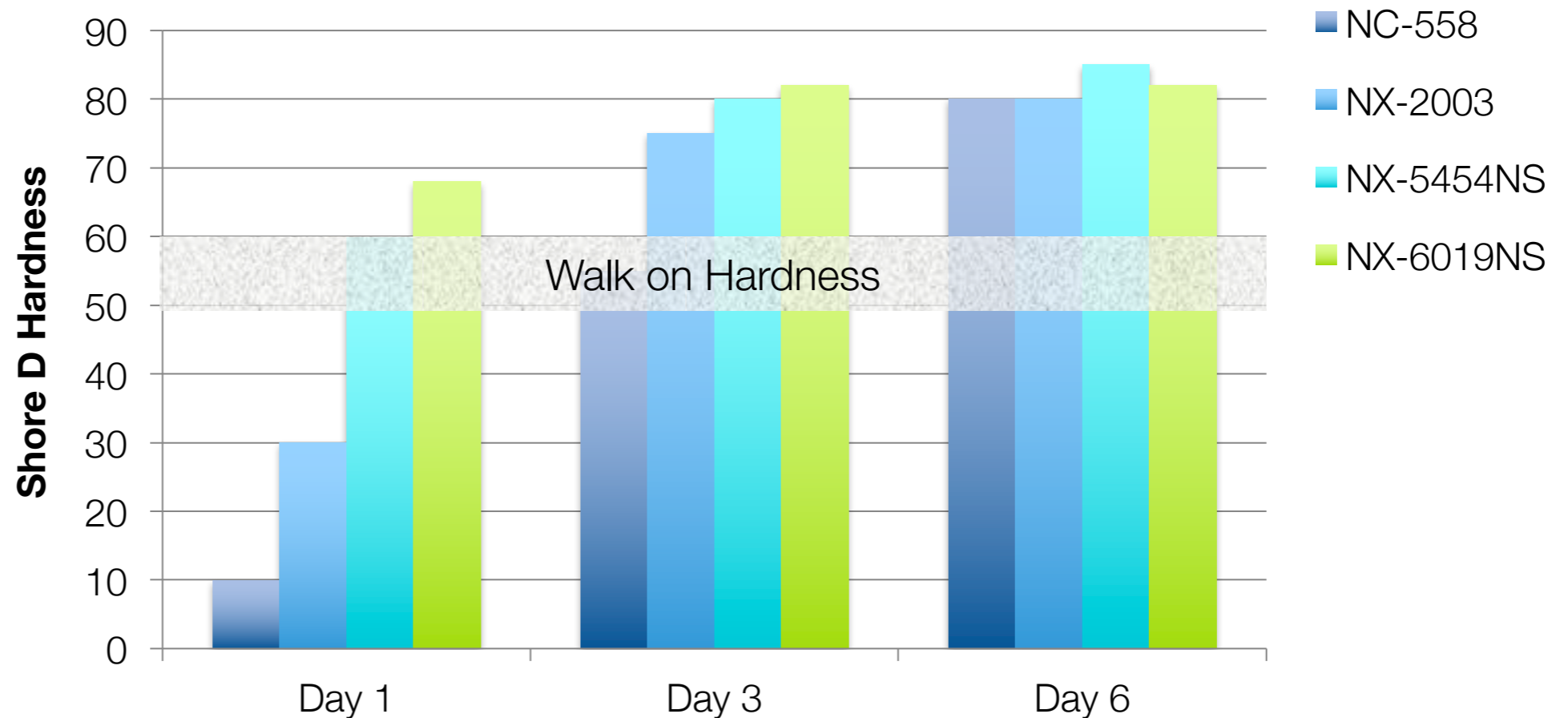
Phenalkamines provide walk on hardness within the first day.

Durometer (Type D) was used to test the Shore D hardness on the flat area.



Hardness Development @ 10°C

10°C cured with BADGE (190 EEW)



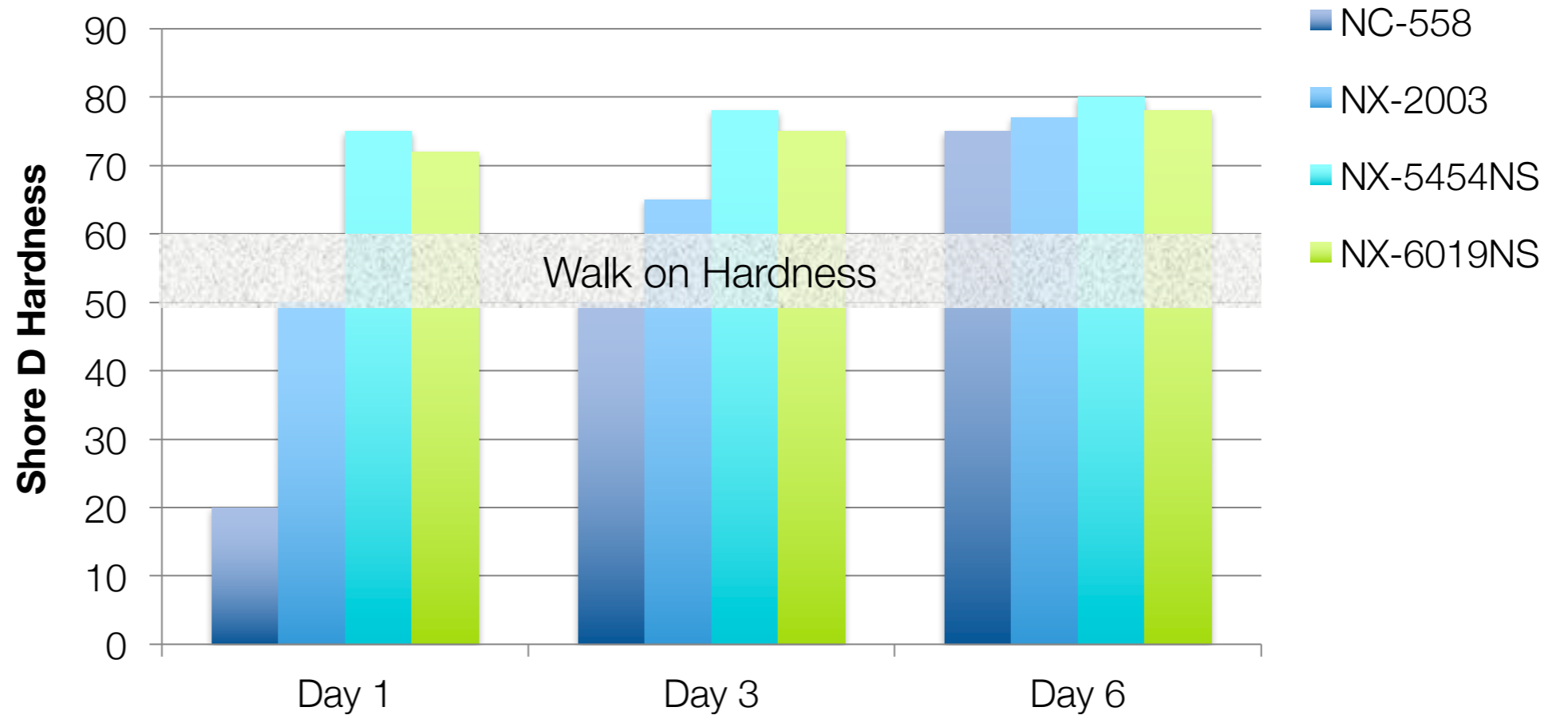
NX-5454NS/NX-6019NS provide walk-on hardness within the first day even at lower temperatures. NX-5140NS should perform similarly.

Durometer (Type D) was used to test the Shore D hardness on the flat area.



Hardness Development @ 25°C

25°C cured with D.E.R. 353



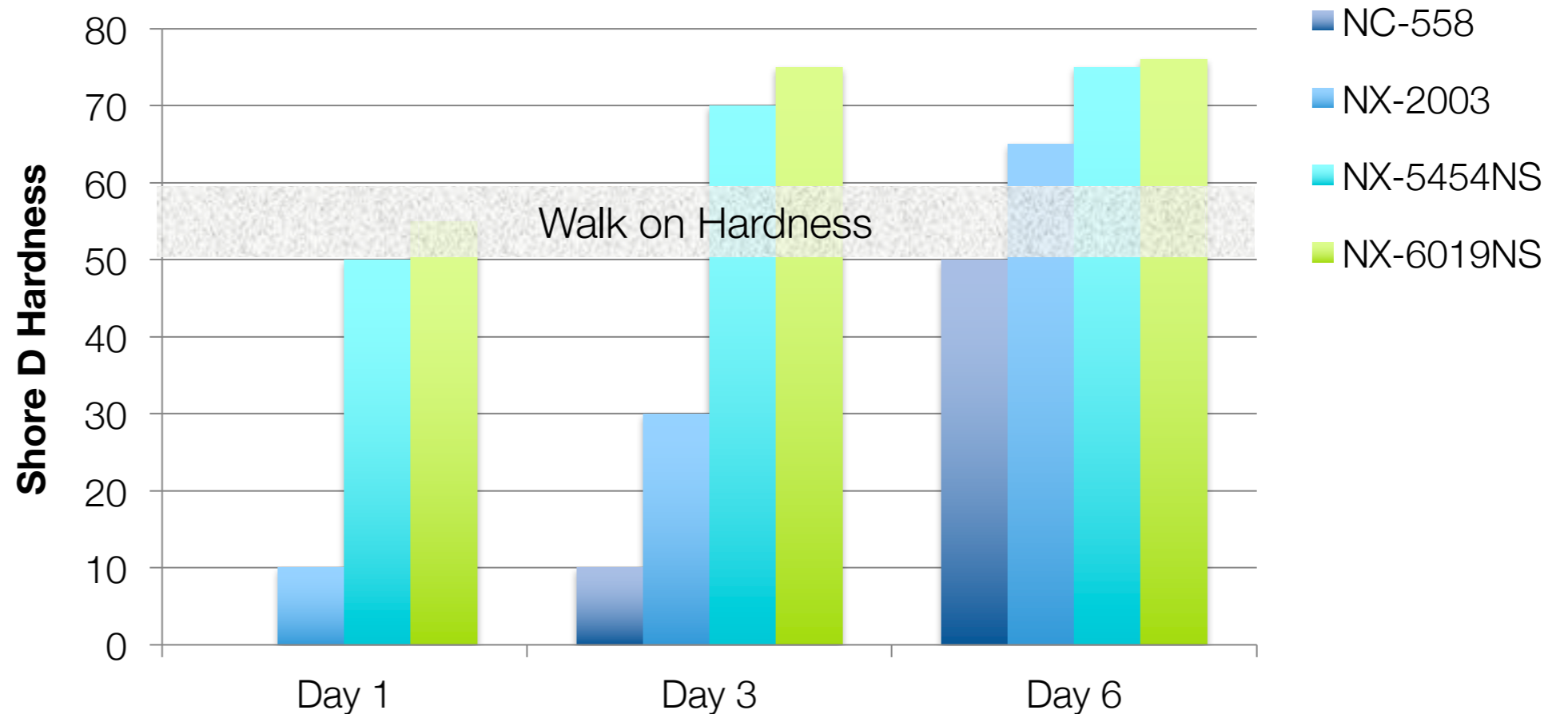
Most phenalkamines provide walk on hardness within the first day.

Durometer (Type D) was used to test the Shore D hardness on the flat area.



Hardness Development @ 10°C

10°C cured with D.E.R. 353*



NX-5454NS/NX-6019NS provide walk-on hardness within the first day even at low temperature in a diluted BisA/F epoxy system. NX-5140NS should perform similarly.

Durometer (Type D) was used to test the Shore D hardness on the flat area.



Mechanical Properties

Curing agent	Resin	Direct impact ¹ (in-lb)	Reverse impact ¹ (in-lb)	Mandrel Bend test ²
NC-558	D.E.R. 353	90	40	1/8"
NX-2003	D.E.R. 353	40	28	1/8"
NX-5454NS	D.E.R. 353	85	65	1/8"
NX-6019NS	D.E.R. 353	62	58	1/8"
Commercial Primer	Fully formulated	16	4	1/8"

DFT 2~2.5mils over CRS panels after 7days cure at RT

¹: ASTM 2794

²: ASTM D 522, the number in inches represents the failure length of the coating film. 1/8" is the best (no failure). 5" is the worst (the coating film fails in its entire length).

Phenalkamines show good mechanical properties.



Vapor Transmission NC-558

Formula: $P = (q \cdot L) / (A \cdot t \cdot dP)$

q: quantity of vapor which traversed the film (Kg)

L: film thickness (m)

A: evaporation surface (m²)

t: duration of the test (h)

dP: difference of pressure between the sealed cup and the environment (Kg/m²)

P: permeability coefficient (m/h)

NC-558 shows low permeability for water/vapor protection.

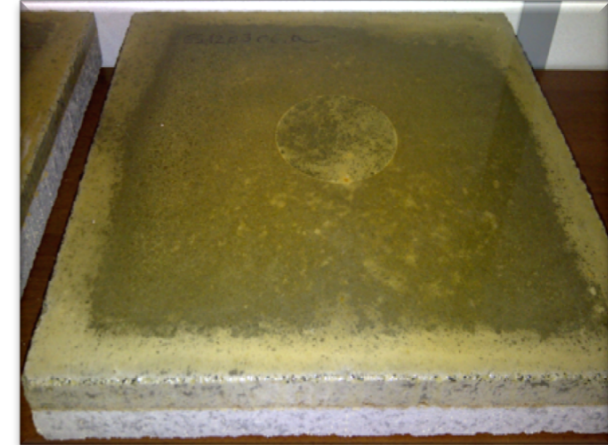
Coating System	P (m/h)
Primer 1 (Cardolite® NC-558)	1.33 E-10
Primer 2 (Cardolite® NC-558 + Euredur 13)	1.32 E-10
Chlorinated rubber	1.94 E-10
Coal tar epoxy	2.91 E-10
Aluminium mastic	4.08 E-10
Read lead-oil based	2.08 E-09
White alkyds	2.48 E-09



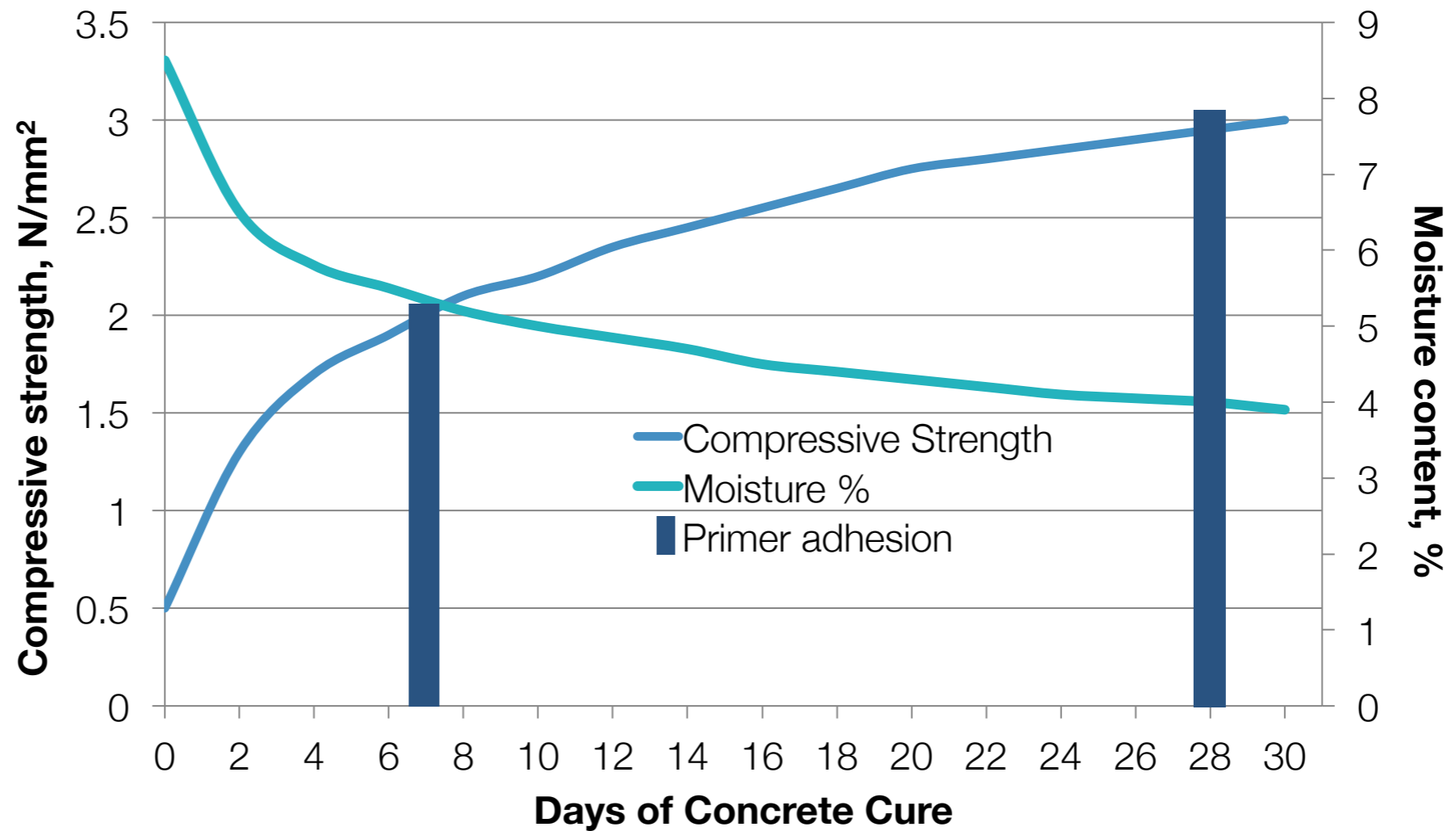
Blistering Tests

- Concrete blocks immersed in water for 2 weeks.
- After 2 weeks, water excess removed and edges and top side are coated (DFT +/- 300µm).
- NC-558 & NX-5454NS were tested in a clear formulation with diluted epoxy.
- Immediately after application of coating, the concrete blocks are partially immersed in water and exposed to the following cycle:
 - 8hr exposure to IR-lamp (150W) 30cm above concrete block
 - 16hr without IR-lamp

No osmotic blistering was observed for both coatings after 3 months of exposure when tests were stopped.



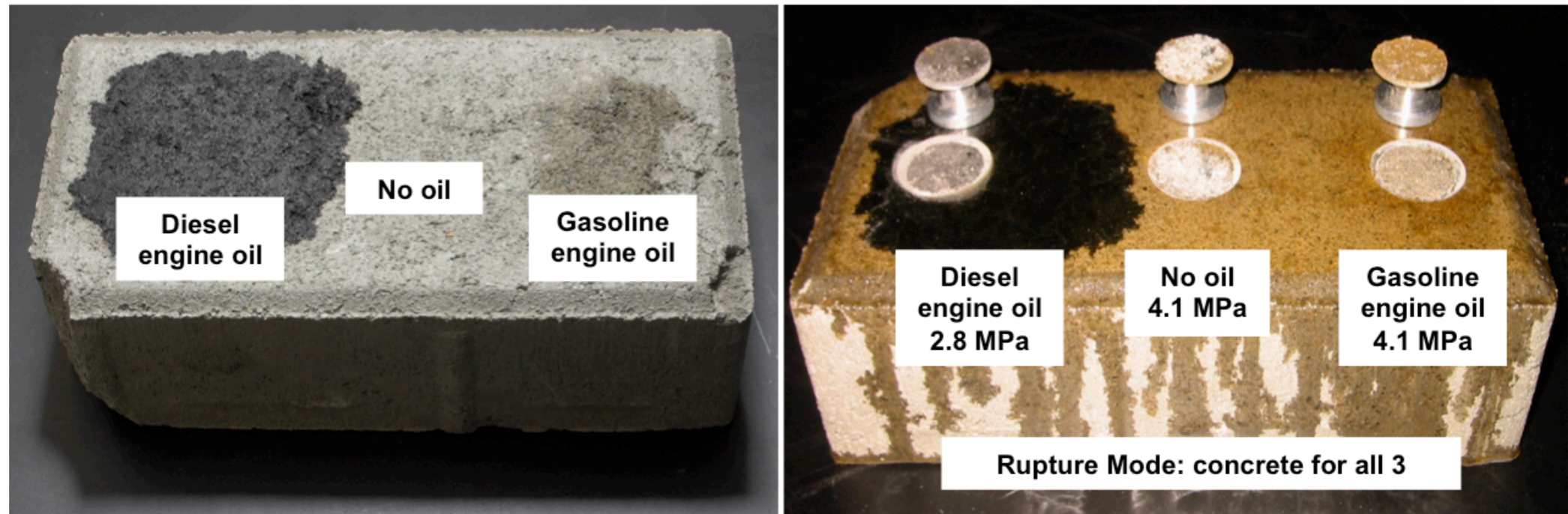
Adhesion to Green Concrete



Concrete requires 28 days to fully cure, but primers based on phenalkamines can develop good adhesion with concrete earlier than that (NC-558 tested).
Performance will vary depending on cure conditions, primer formulation and concrete type.



Adhesion to Oily Surfaces



Pull off adhesion on oily surface is similar to that of uncontaminated concrete (rupture mode is in the concrete)

*Product tested, NC-558



Typical primer formulation

	NX-5454NS	NC-558
Part A		
DER 353 (low viscous diluted A/F resin)	100	100
Part B		
Cardolite® NX-5454NS (phenalkamine curing agent)	70	-----
Cardolite® NC 558 (phenalkamine curing agent)	-----	50
Ancamide K 54 (Tertiary amine, used as accelerator)	-----	1.50
Anti-Terra 202 (High molecular weight wetting and dispersing additive)	0.75	0.75
Byk A 501 (Silicone-Free Air Release Additives)	1.50	1.50



NX-5454NS & NC-558 Adhesion to Damp Concrete

- Concrete blocks immersed in tap water for 24 hrs, then freestanding water on the top was removed by blotting with paper towels.
- Epoxy primer was applied with a $\frac{1}{4}$ " nap roller with a front-to-back and side-to-side pattern. After 5 minutes, another layer was applied with a drawdown bar to ensure 10 mils DFT.
- PU top coat applied after 18 hours of primer cure. The topcoat applied with a $\frac{1}{4}$ " nap roller.
- Elcometer dollies were attached (Araldite 2011) to the cured film surfaces after 24hr cure. The dollies were allowed to cure for 24 hours to 3 weeks before adhesion pulls were made.



	24-hour Cure	3-Week Cure			
	Dry Concrete	Dry Concrete		Damp Concrete	
System	Primer Alone	Primer Alone	Topcoat Over Primer	Primer Alone	Topcoat Over Primer
NX-5454NS	600 psi 4.1 MPa	1000 psi 6.9 MPa	800 psi 5.5 MPa	550 psi 3.8 MPa	300 psi 2.1 MPa
Rupture mode	Dolly to adhesive	Dolly to adhesive	Dolly to adhesive	100% concrete	100% concrete
NC-558	1000 psi 6.9 MPa	1000 psi 6.9 MPa	600 psi 4.1 MPa	500 psi 3.4 MPa	500 psi 3.4 MPa
Rupture mode	50% concrete 50% Dolly to adhesive	Dolly to adhesive	50% concrete 50% Dolly to adhesive	100% concrete	100% concrete

NX-5454NS & NC-558 Adhesion to Concrete





Conclusion

- Cardolite offers excellent options for concrete solvent-free primers
- These phenalkamines are low viscosity, solvent and benzyl alcohol free, and exhibit good pot life
- Our product offering includes phenalkamines with:
 - Very fast cure even at low temperatures
 - Excellent film appearance
 - Fast hardness development
 - Excellent adhesion to green, damp, and dry concrete
 - Combination of high hydrophobicity, low permeability, and excellent adhesion that prevents osmotic blistering