PRIMERS FOR POLYUREA IN CONCRETE REFURBISHMENT APPLICATIONS

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WHY ARE PRIMERS IMPORTANT ?

POWER IS NOTHING WITHOUT CONTROL
Polyurea Surface Preparation Polyureas can be formulated with some remarkable physical properties including enhanced adhesion. However, there is rarely a successful polyurea application that does not include proper surface preparation and testing.

In addition to proper surface preparation procedures and techniques, the use of primers is strongly recommended in most applications. You should always consult your material supplier for the best compatible system/primer combination for each particular substrate.
WHY ARE PRIMERS IMPORTANT

• A PRIMER IS WHAT BONDS POLYUREA TO SUBSTRATES.

• CONCRETE IS A POROUS MATERIAL. IT IS THEREFORE VERY IMPORTANT TO SEAL CONCRETE PROPERLY WHEN SPRAYING HOT MATERIALS OVER IT.

• CONCRETE MOVES AND MAY CRACK. POLYUREA MUST SURVIVE CRACKS IN CONCRETE.

• CONCRETE MAY CONTAIN HUMIDITY.
PRIMERS FOR POLYUREA

• THERE IS MUCH DEBATE ON WHICH PRIMER IS BETTER TO APPLY POLYUREA ONTO CONCRETE.

• THIS IS INFLUENCED BY MANY VARIABLES AND THERE ARE MANY OPTIONS AVAILABLE IN THE MARKET.

• THIS STUDY IS MADE IN ORDER TO CLARIFY SOME CONCEPTS AND VALIDATE THEM WITH LAB TESTS.

• GOAL: FIND THE RIGHT PRIMER FOR EVERY JOB, DEPENDING ON CURING TIME AVAILABLE AND OTHER FACTORS.

• VARIABLES: PEEL & PULL STRENGTH VS CRACK RESISTANCE (ADHESION / COHESION).
SOME TOPICS ON PRIMERS:

- EPOXY PRIMERS ARE BRITTLE AND CAUSE BREAKS IN THE POLYUREA. POLYURETHANES ARE FLEXIBLE AND RESIST CRACKING.
- EPOXY YIELDS TO CHEMICAL LINKS BETWEEN OH/NH2 OF EPOXY AND NCO IN POLYUREA.
- EPOXY PROVIDES BETTER ADHESION TO SUBSTRATES THAN POLYURETHANES.
- THERMOPLASTIC PRIMERS ARE LIMITED BECAUSE POLYUREAS ARE THERMOSTABLE (DIFFERENT TEMPERATURE BEHAVIOUR).
- FAST CURING POLYASPARTIC PRIMERS ARE GAINING MOMENTUM FOR THE POLYUREA MARKET.
- 3 PACK MOISTURE BARRIERS MAY REQUIRE A TOP LAYER TO SEAL THEM BEFORE SPRAYING POLYUREA ON TOP.
PRIMERS FOR POLYUREA
PRIMERS FOR POLYUREA

EPOXY RESINS
- 100% SOLIDS 2/1 STANDARD EPOXY
- WATER BASED EPOXY
- FLEXIBLE EPOXY
- HOT SPRAY APPLIED EPOXY (1:1)
- 3 PACK MOISTURE BARRIER EPOXY

POLYURETHANE RESINS
- 2 PACK STANDARD HARD PU (ether/ester + MDI).
- 1 PACK SOLVENT BASED HARD PU
- 1 PACK SOLVENT BASED FLEXIBLE PU
- 1 PACK SOLVENT FREE HARD PU

POLY ASPARTIC RESINS
- 100% SOLIDS 1 TO 1 SYSTEM

SILANE BASED PRIMERS
- SOLVENT BASED BRUSHED / INVISIBLE PRIMER (ACTIVATOR)

WATER BASED ACRYLIC RESIN
PRIMERS FOR POLYUREA

• TESTS PERFORMED:
  – PULL ADHESION.
  – PEEL ADHESION.
  – CRACK RESISTANCE.
PRIMERS FOR POLYUREA

• PULL ADHESION
PRIMERS FOR POLYUREA

- PEEL ADHESION

**Peel/Adhesion Test:** The measurement of the adhesive or bond strength between two materials, expressed in ounces/inch.
PRIMERS FOR POLYUREA

• CRACK RESISTANCE

1. GENERATE A CRACK IN SUBSTRATE.
2. DETERMINE HOW MANY mm OF CRACK WIDTH SYSTEMS CAN SURVIVE.
PRIMERS FOR POLYUREA

• GOAL: IS IT POSSIBLE TO FIND AN EQUATION WHERE

\[
\text{CRACK RESISTANCE} = a \times \text{(PULL STRENGTH)} + b \times \text{(PEEL STRENGTH)}
\]

THAT IS, FOR A GIVEN POLYUREA, CAN WE KNOW THE BEST PRIMER (WITH THE HIGHEST POSSIBLE ADHESION), WHICH ALSO HAS CHANCES OF SURVIVING A CRACK?

AND THE BEST WAY TO APPLY IT (HOURS BETWEEN PRIMER AND MEMBRANE SPRAYING)?

PDA Europe 2014 Annual Conference - Krakow, 5-7 November
ADHESION VS ELONGATION

No Primer

Acceptable

Desirable

No

Elongation, crack bridging

Adhesion to substrate
PRIMERS FOR POLYUREA

• CAN WE SPRAY POLYUREA DIRECTLY ONTO CONCRETE???

- POLYUREA MAY HAVE ACCEPTABLE ADHESION BY ITSELF (SOMETIMES HIGHER THAN CERTAIN PRIMERS).
- PRIMERS ARE LIKELY TO CAUSE A WORSENING OF POLYUREA CRACK BRIDGING.
- BUT POLYUREA NEEDS A SEALER OVER CONCRETE IN ORDER TO AVOID PINHOLES !!!
TEST SPECIMEN CRACK BRIDGING*

POLYUREA RAYSTON

Gel time: 3 s at 60\(^\circ\)C  
Shore Hardness: 87A  
Elongation (free film): 320%  
Tensile strength (free film): 16 MPa

Application conditions:  
A: 55-65\(^\circ\)C  
B: 65-70\(^\circ\)C  
140 bar
LONG-TERM ADHESION FINDINGS

Adhesion, Pull-off (MPa)

- 1k Solvent free hard PU
- 1k Solvent hard PU
- 1k Solvent flex PU
- 2k standard hard PU
- WB Epoxy 1
- WB Epoxy 2
- 2/1 Standard EP
- Spray applied EP
- Standard Primer EP for concrete
- Flexible EP
- Polyasp. 1/1
- 1k-PU competitor
- 2k-PU competitor
- Silane based
- 3k moisture barrier EP
- WB acrylic
ADHESION vs ELONGATION

GENERAL FINDINGS

[Graphs showing adhesion vs elongation for various materials: 1k Solvent free hard PU, 1k Solvent hard PU, 1k Solvent flex PU, 2k standard hard PU, Blank, WB Epoxy 1, WB Epoxy 2, 2/1 Standard EP, Spray applied EP, Standard Primer EP for concrete, Flexible EP.]

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ADHESION vs ELONGATION

GENERAL FINDINGS

- Polyasp. 1/1
- 1k-PU competitor
- 2k-PU competitor
- Silane based
- Blank

- 3k moisture barrier EP
- WB acrylic
- Blank
ADHESION vs ELONGATION
Primer options

If considering only adhesion:
1k Solvent hard PU
Standard Primer EP for concrete
Flexible EP
3k moisture barrier EP

Best acceptable adhesion/elongation balance
Hot Spray applied EP (1:1)
1k-PU competitor
Hot Spray-applied (1:1) Epoxy Primer developed by Krypton Chemical

Formulated polyamidoamine adduct, slightly brittle

Can be applied by high pressure small unit (Hydraulic, Pneumatic, Electric) and cures in few hours (faster than conventional Epoxy primers).
ADHESION vs ELONGATION

Time gap (primer/coating) influence on Adhesion / elongation ratio

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**Graph 1:**
- **X-axis:** Elongation mm
- **Y-axis:** Adhesion MPa
- **Legend:**
  - Blue diamonds: 10 days
  - Red square: Blank

**Graph 2:**
- **X-axis:** Elongation mm
- **Y-axis:** Adhesion MPa
- **Legend:**
  - Blue diamonds: 48h
  - Red square: Blank
ADHESION vs ELONGATION

Time gap (primer/coating) influence on Adhesion / elongation ratio
ADHESION vs ELONGATION

Time gap (primer/coating) influence on Adhesion / elongation ratio
ADHESION vs ELONGATION

Is time-dependent?

>48 h: Adhesion wins over elongation.

24-48 h: Inverse adhesion-elongation relationship. Possible compromise. An equation might be found to link both variables.

3-6 h: Inconclusive. Too much influence depending on specific product behaviour.
ONGOING WORK

Establish a working time for every primer which will deliver its best adhesion / elongation value depending on each specific need or project (waterproofing vs flooring).

The case of wet concrete
Case of metal surfaces
CONCLUSIONS

1. THERE ARE MANY POSSIBLE PRIMERS FOR POLYUREA ONTO CONCRETE.

2. THERE IS A BEST OPTION FOR EVERY PROJECT (ADHESION/ELONGATION).

3. FORMULATORS MUST PROVIDE ENOUGH GUIDANCE AND INSTALLERS MUST RESPECT WORKING TIMES AND APPLICATION METHODS.
Thank you

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PEEL ADHESION vs ELONGATION

Graph 1:
- 1k Solvent free hard PU
- 1k Solvent hard PU
- 1k Solvent flex PU
- 2k standard hard PU
- Blank

Graph 2:
- WB Epoxy 1
- WB Epoxy 2
- 2/1 Standard EP
- Spray applied EP
- Standard Primer EP for concrete
- Flexible EP
PEEL ADHESION vs ELONGATION

- Polyasp. 1/1
- 1k-PU competitor
- 2k-PU competitor
- Silane based
- Blank

- 3k moisture barrier EP
- WB acrylic
- Blank
PEEL ADHESION vs ELONGATION
Primer options

If considering only adhesion:
1k-PU competitor
3k moisture barrier EP

Best acceptable adhesion/elongation balance
Spray applied EP
1k-solvent flexible PU
PEEL ADHESION vs ELONGATION

Is time-dependent?

![Graph showing peel adhesion vs elongation for 10 days and 48 hours, with data points and a line of best fit.](image-url)
PEEL ADHESION vs ELONGATION

Is time-dependent?

![Graph showing peel adhesion vs elongation over time (24h and 6h).](chart.png)
PEEL ADHESION vs ELONGATION

Is time-dependent?

![Graph showing peel adhesion kg/cm vs elongation mm for 3h and Blank samples.](image)
PEEL ADHESION vs ELONGATION

Is time-dependent?

>24h: Adhesion wins.
24 h: Inverse adhesion-elongation relationship. Possible compromise.
3-6 h: Inconclusive. Case-by-case