

# RESEARCH BRIEF

2001/001

## Developing A Durable Polyurethane Sealant That Can Withstand Tropical Conditions

This research is targeted at developing a polyurethane construction sealant that can withstand the harsh conditions of the tropical climate.

Serious sealant failures have been observed on external joints in buildings and structures in tropical countries like Singapore (Figures 1 & 2).

The underlying cause is that the currently used commercial sealants are formulated for non-tropical countries and considerations of the impact of the tropical climate were not made during their formulation. As a result, there is a need for a construction sealant that is specially developed for the tropics.

### METHODOLOGY

The formulation of a durable polyurethane sealant was focused on raising the resistance against 70°C water immersion, resulting in a 70°C-water immiscible sealant, which was then embellished by

considerations of performance under QUV weathering, 70°C air and repeated American Standard Testing Method (ASTM) C719. Simplified testing accompanied the whole formulation to monitor its effectiveness.

Finally a set of comprehensive tests was designed and used to evaluate the durability of the end product under simulated tropical conditions in terms of cohesion, adhesion and movement capability.

### MERITS OF THIS SELF-DEVELOPED SEALANT

The salient features of this sealant are:

- 1) It retained more than 90% of its tensile strength after a 28-day immersion in 70°C water and 500-hour QUV weathering (ultraviolet at 70°C and condensation at 50°C).
- 2) Good peel adhesion to concrete without the need of a primer (ASTM C794) (Figure 3).
- 3) Good resistance to movement capability (repeated ASTM C719) (Figure 4).

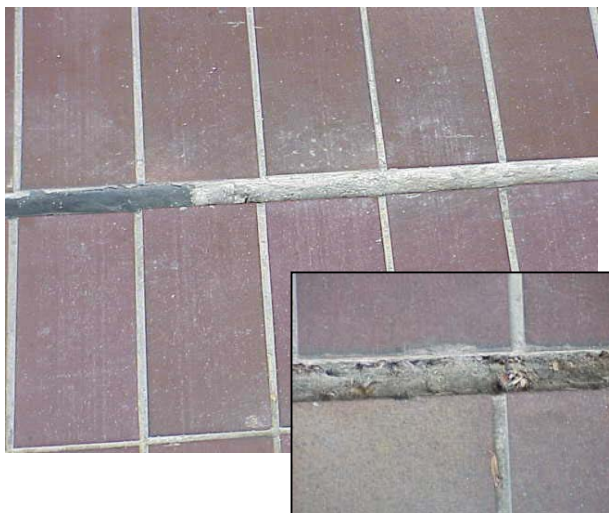


Figure 1. A two-metre long commercial sealant peeled off the substrate due to adhesive failure on the external expansion joint of a building.



Figure 2. A length of failed commercial sealant on an overhead bridge.



Figure 3. 100% cohesive failure was shown in the peel-adhesion test (ASTM C794) of this sealant to concrete without primer after a 28-day immersion in 70°C water. (The larger the percentage of cohesive failure given by ASTM C794, the stronger the peel adhesion.)

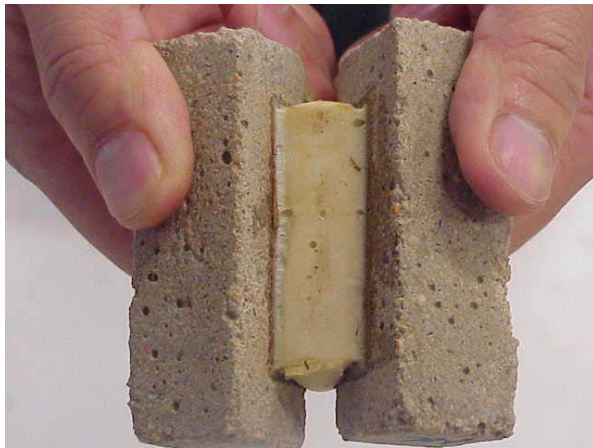


Figure 4. Perfect adhesion and cohesion were shown above after the fifth cycle of repeated ASTM C719 on this sealant.

There was less than 5% total adhesive and cohesive failure loss after the fifth cycle. (Each cycle comprised a 7-day immersion in ambient water, 7-day exposure to 70°C air and 10 cycles of 25% alternating extension and contraction.)

Advanced instruments like Attenuated Total Reflection (ATR), Differential Scanning Calorimetry (DSC) and Thermal Gravity Analysis (TGA) were also employed to characterise this product (Figures 5 to 7).

## FUTURE WORKS

Large-scale tests are to be conducted on self-developed racks and field-performance analyses implemented on actual sites. Meanwhile the scope of the product forms shall be broadened to include non-sag/self-levelling, trafficable/ non-trafficable, low/medium/high modulus sealants, even waterproof membranes, crack sealers and so on; all of them aim to sustain high durability in the tropics.

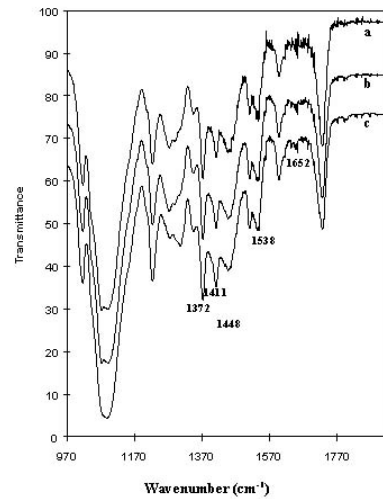


Figure 5. ATR spectra of the surfaces of sealant B: (a) control specimen; (b) specimen immersed in 70°C water for one week; (c) specimen immersed in 70°C water for four weeks. (Based on ATR results, no obvious degradation occurred due to hot water immersion.)

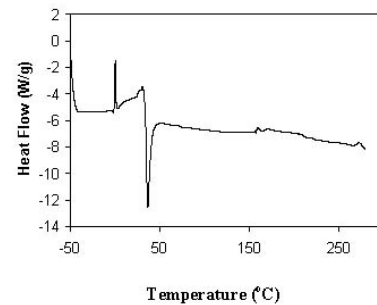


Figure 6. DSC result of this self-developed sealant.

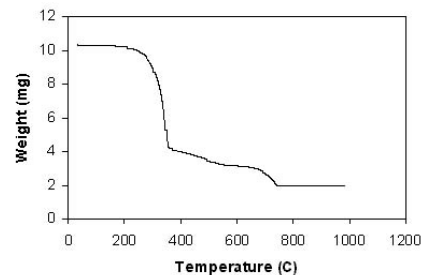


Figure 7. TGA graph of this self-developed sealant.

## CONTACT DETAILS

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